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Original Articles

PSYCHOLOGIC EFFECTS OF MALOCCLUSION OF THE TEETH

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ALBUCASIS (936-1013), the noted physician and surgeon, stated in his book *De Chirugia,* that "when a tooth is irregularly placed or projects above the level of the others, a deformity ensues which is particularly displeasing in women." This terminology is, of course, a bit different from that used by orthodontists today in their classification of malocclusion of the teeth; however this statement made about one thousand years ago is construed by me as applying to the unfortunate psychologic effects of such deforming conditions. The study of this aspect, with its far reaching effects, is one of the most interesting phases of orthodontics, and one which many are prone to disregard as a very definite part of the orthodontic problem.

Medical science recognizes that the psychologic and physical components of humans are very closely interrelated, and that unless both aspects are dealt with at the same time in the treatment of diseases, the prognosis cannot be a favorable one. This is especially true in dealing with children, as they frequently lack the reasoning powers possessed by adults, and which are necessary in controlling the emotions. For example, no matter how skilled the physician is in administering to the physical ailments of his patients, if he cannot also administer to their emotions when needed, he will find that his end results will fall short of a satisfactory cure. My purpose, however, in dealing with this subject is not to attempt to put the orthodontist in the role of psychologist, but to point out that the psychologic effects of malocclusing teeth should be more readily recognized as having a prominent place in orthodontics.

As a beginner in dentistry, I looked upon orthodontics as having as its chief aims the improvement of facial appearance and the establishment of a better masticatory apparatus. I failed to recognize fully that the successful treatment of certain deformities of the face, due to malocclusion of the teeth, played an

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important part in changing the mental attitude of persons so afflicted. This was impressed upon me soon after I began the practice of orthodontics, when the mother of a patient, in referring to her daughter, made the remark that she could never be too grateful for the fact that there was a profession such as ours, which could take an individual who had been a timid, reserved, and outwardly dull person, and bring about such an improvement in her appearance, that her entire outlook on life had been changed.

Dr. David Forsythe, consulting physician for the Evelina Hospital in London, stated that "facial disfigurements such as congenital nevi (port wine stains), harelip, and squint, being noticeable by everybody, often react on a child's mentality." I have found that those individuals who are afflicted with those types of malocclusding teeth, which I prefer to term as the "disfiguring" or "psychologic types," also can just as readily be disturbed in their mental adjustments.

It is an established fact that most psychologic maladjustments in later life have their origin in childhood, and I endeavor to look upon a patient who is afflicted with a dental or oral deformity with utmost sympathy, and with a firm determination on my part to prevent that patient from being a "dental recluse" as an adult. It is not my purpose to leave the impression that all individuals who, in the terms of the laity, possess "buck-teeth," "jimmy-jaws," or "air-cooled" teeth are to be considered psychologic problems. We all can cite quite a number who are thus afflicted, but who possess charm, personality at its best, and other characteristics which make them not only acceptable, but outstanding personalities. I do believe, however, that the majority of them labor under some psychologic maladjustment, even though it is well covered up.

Elementary though it may seem, I think it worthy of discussing some of the more common characteristic traits noticed in those with disfiguring dental anomalies, especially children and youth. A child is not always able to comprehend the reason why he or she should not possess normal features. Some of them doubtless think that their disfigurement is a form of punishment for some act or acts of misbehavior which carries with it a certain sense of guilt. Most of them, however, just realize that they are different from other children, and various psychologic maleffects result, the nature of which is dependent in a large measure upon the environment at home and school.

The most common trait found is, I believe, that encountered when a child believes himself to be inferior to other children; i.e., an inferiority complex. This is, in my opinion, the type of child who brings out our best sympathies, and this fact, soon apparent to the child, will help combat this trait if tact is employed, but will tend to aggravate it if a wrong approach is used. We must avoid anything which might aid in the development of "self-pity," and seek the cooperation of parents in this objective.

John R., aged 10 years, was brought in to see me by his mother, with a pronounced Class II, Division 1, dental anomaly. One could easily see that the child was living in a world almost by himself, with his mother and father as a protective force to go to for sympathy from being constantly reminded by his classmates at school of his disfigurement. John confessed to me after several visits that everybody called him "horse-tooth" and "buck-tooth" instead of a

friendly "John" or "Johnny." After gaining the child's confidence, he gradually "opened up" with me, and I could easily see that he really believed himself inferior to others about him, more particularly the children. Not being possessed with that faculty of asserting himself, and thereby attempting to overcome his affliction (a classification which is later discussed), he had sought and received protection at home. My big problem in this case, other than correcting his dental anomaly, was to convince the child that although it was true that he had prominent teeth, the condition could be corrected, and that he was just as healthy and intelligent as those who chided him, and perhaps more so than most of them. Also that he was fortunate that his parents were able to have the correction made. The parents were also instructed to discontinue the unwise show of too much sympathy. Several months after treatment was instituted, this child began to assume a different attitude, not that the condition had been entirely corrected, but because he had been convinced that he was not inferior to his playmates, and also that he would soon be able to present a normal facial appearance. This child even gradually assumed an almost bragging air about "wearing braces."

There are also children who, as a result of some types of disfiguring malocclusing teeth, are capable of building up an attitude of superiority, which, I believe, is an attempt to cover up their affliction. Some call this a defensive reaction of an inferiority complex, but the matter of definition is of little consequence. I particularly admire this type because they have accepted their lot without apparent grudge, and are fighting to overcome a situation without any outside aid. Under treatment these children have been found to be most pleasant to deal with. We may compare them with the individual who carries around too much avoirdupois, but who is commonly accepted as being jolly. Demosthenes, you will recall, was afflicted with a bad stammer, but conquered this impediment of speech and became one of the greatest orators of all time. To further exemplify this trait, we may recall that we have all observed in side shows, freaks who emphatically display a more or less superior air. Only several days ago, I had the opportunity to verify my belief that this superiority complex exists, but that it does have its limitations. A married women, aged 40 years, whom I had known socially for quite some time, came to see me professionally. She was always one of the most attractive in any group where circumstances placed her. She possessed, however, a disfiguring Class II, Division 1, case, which was gradually getting worse. She confessed that ever since she was a young girl she had been conscious of her facial appearance and that she had always tried to convince herself that even though she had a disfigurement, she should accept it and strive to be just a little bit better than the others with whom she was thrown. She informed me that now she had a mortal fear of the condition becoming more noticeable, and that if it did, she was just going to "give up and stay at home." The latter she said in a half-hearted laughing vein, but one could easily read the anxiety in her expression. Here was a person who from childhood had a physical deformity, and had been conscious of it as detrimental to her appearance, but had succeeded in throwing aside her consciousness by assuming a superior attitude, not, however, to a disagreeable degree. Many factors, which are not of interest here, prevented my treatment of the case. However, I did relieve her anxiety my making a Hawley retainer, de-

signed so as to prevent, I trust, the condition becoming worse, and also probably helping to correct it to a certain extent.

Another trait which we so often find is that of timidity. I can best illustrate this in the case of a high school girl whose maxillary incisors were biting lingually to the mandibular incisors. In consequence, there was a marked depression of the upper lip, with the nose and chin assuming overly prominent proportions. In our conversations she proved to be a most intelligent girl, and I noticed that she was well liked and respected among her associates. However, she lacked that assertive power which would make her a leader of any group. Due to her disfigurement she was lacking in spirit, courage, and faith in herself, necessary to surmount it. On numerous occasions she remarked to me that she was "ashamed to open my mouth when anyone was looking." Yes, the story has a good ending, for I did obtain a nice result in correcting her occlusion, and also in changing her appearance to normal, thereby placing her on an equal footing with others. She finished high school as valedictorian of her class, and is now secretary to an official in one of our largest industries in this locality, a position I believe she never could have obtained had not the correction been made. This patient often comes in to see me now, and I experience a sense of pride in seeing a person with an entirely different attitude than she had when I first saw her. It is also a source of satisfaction to be a member of a profession capable of rendering such service.

Selfishness is another abnormal mental trait noted in these disfiguring types. It is quite natural, in most instances, for parents to be oversolicitous of their children when they are afflicted in any way, especially with a noticeable deformity, be it facial or otherwise. These pampered children will often take advantage of their parents and will demand more and more of them as time goes on, not only of their attention, but of material things as well. This is apparent not only in cases of an "only child," but also where there are several children. Here the afflicted child assumes the attutude that he or she should have the best of everything available.

We are all familiar with those individuals who resent the fact that what they possess is not as good as what the other fellow has. We term that characteristic "jealousy." This trend of thought, in my opinion, also can be found in certain children, who, upon reaching the appreciative age, are jealous of an associate, be it in the same family or outside, for possessing a prettier set of teeth. This trait is not as prevalent among young children as among adolescents. To illustrate, the following case came to my attention: Two girls of about the same age were inseparable companions until they reached that inevitable age when beauty begins to count more and more. Both girls were healthy, normal individuals, with the exception that one had a reasonably pretty mouth, and the other had both maxillary cuspids in marked labioversion. The latter became very sensitive about her appearance, and as time passed, her sensitiveness became a very evident jealousy. A life-long friendship in the making turned into a mere former acquaintanceship, and I believe it was a result, in a great measure, of the effect of disfiguring malocluding teeth.

All persons to a certain extent are sensitive; however, when one has a deformity, this common trait may resolve into supersensitiveness. We are told

that Byron, the poet, who was affected with a clubfoot was so sensitive about it that he would take every precaution to prevent his condition from being noticed. So it is with certain children possessing disfiguring dental anomalies; their sensitiveness grows into supersensitiveness, which makes us describe them as "very touchy children."

Again let me make it clear that I do not believe that every child or adult who has a disfiguring dental anomaly is a true psychologic problem. Dr. Forsythe tells us of two young ladies who had very disfiguring birthmarks on their faces. One of them had become so sensitive about her disfigurement that she avoided all social relations and went out only after dark, whereas the other followed contentedly an everyday life. We too can cite cases of individuals who are handicapped by some physical deformity, and who are activated by it to carry on with a stronger driving force to succeed in life, than had not the physical deformity been present. Among my friends is one who has a most disfiguring type of malocclusing teeth, and yet I have never noticed any outward psychologic effect of it on him. In my opinion his disfigurement from childhoood probably developed in him an exceptional fortitude of character which has become a great asset in his adult life. He has a pronounced Class III case, and as a result is known and called by his friends as "Jaw," which is, as we know, very descriptive of these cases. In referring to this latter group who have taken advantage of their deformity in using it as an asset, I am reminded of several lines of a poem which has always been a favorite of mine, and which exemplifies the ability of someone to overcome life's obstacles:

"We gain our rest through weariness,
From bitter draw the sweet;
Strength comes from weakness, hope from fear,
And victory from defeat."

Malocclusing teeth may result in forms of bodily illnesses, which are not associated with mental changes, but when the condition is such that it renders proper mastication impossible, and this is allowed to persist over a period of years, we know that digestive disturbances often set in, which in turn are capable of producing mental traits, such as nervousness, irritability, etc. These cases are not so common, but in my practice I can recall two where mastication was impossible to any extent. One was a girl, 14 years of age, who presented a Class II case, where the whole mandibular arch was lingual to the maxillary. Upon examination I found that treatment could not be instituted immediately, due to a marked ulcerated condition of the tongue and soft tissues of the mouth. She was referred to a diagnostician for a thorough medical examination, and in order that the ulcerations could be cleared up (which we realize would be temporary in nature), so treatment could be started. The child gave a history of digestive upsets (pain, regurgitation, and a sense of abdominal fullness after meals). Physical examination was essentially negative, with the exception of a slightly tender mass in the epigastrium about the size of a walnut. The physician's impression of this girl was that she had a functional blockage of the stomach at the pylorus, and that the condition of the oral cavity was secondary to the stomach trouble, which in turn was brought about in a great measure by

lack of mastication. Her physician gave her medical treatment consisting of phenobarbital and belladonna, in conjunction with an easily digestible diet. This child displayed a case of extreme nervousness and irritability.

The other case was a girl, 9 years of age, who presented a similar dental anomaly and was described by her mother as being definitely nervous, and as she put it, "because, I imagine she suffers so much with indigestion," which was in my opinion a correct diagnosis to a marked degree. There was no evidence or any history of ulcerations of the oral cavity; however, the "tone" of the gingivae, was, of course, typical of that found in dentitions suffering from lack of function. Both of these cases, I am happy to say, responded favorably to treatment.

In conclusion may I repeat, that in presenting this paper for your consideration it has not been my desire to assume the role of a psychologist, but to discuss briefly and in a general way the part that malocceluding teeth are capable of playing, and in being responsible for some of the more common traits of the mind, especially as shown in behavior. These traits here discussed are: inferiority complex, superiority complex, timidity, selfishness, jealousy, supersensitiveness, an exceptional fortitude of character used as an asset to overshadow a deformity, nervousness and irritability. Finally, we as orthodontists have not only rendered a service of immeasurable value to the patient throughout life, but have received that something which makes the pursuit of life's work a happier one.

FURTHER INVESTIGATIONS OF BONE CHANGES RESULTING FROM EXPERIMENTAL ORTHODONTIC TREATMENT

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INTRODUCTION

This report is a continuation of previous investigations of tissue changes which take place incident to orthodontic movement of teeth.

The changes in the alveolar processes, in other words, the mechanism of artificially induced tooth movement, has been clarified by a number of investigators throughout the last several decades. Contributors to this field of research include Sandstedt,[1] Oppenheim,[2] Gottlieb and Orban,[3] Kronfeld,[4] Marshall,[5] Stuteville,[6] and others.

The investigations of these authors cover the effects of orthodontic treatment on the teeth and the alveolar processes proper. No evidence of any influence of orthodontic treatment on bony parts other than the alveolar processes was published. That such an influence might exist had been felt by some orthodontists, both practitioners and investigators. We deduce this from reported efforts of various authors to influence facial contours or to change the position of the mandible. For example, Calvin S. Case[7] contended that "the facial outlines should always be considered" and that "all of that large class of cases whose teeth are in *normal occlusion* but with overlying facial contours protruded or retruded . . . . should be regarded as *malocclusions, demanding correction* . . . . if the science of dental orthopedia means anything beyond mere correction of irregularities of the teeth."

Such a statement can be construed only to mean that changes outside the alveolar processes should be artificially induced, for, if there is normal occlusion, little can be done within the alveolar processes to correct protrusion or retrusion. The way of achieving such correction would be to influence extra-alveolar areas.

Previous experiments performed by the author on monkeys indicated that the influence of orthodontic treatment is not confined to the alveolar processes, but extends beyond these organs to other parts of the skull, causing bone transformations in the temporomandibular joint, ramus, body and angle of the mandible. These bone transformations were correlated to specific types of treatment. It could be demonstrated that:

1. Intermaxillary rubber bands caused not only migration of the teeth but also changes of the shape of the mandible at the ramus, condyle, and angle. These bone changes corresponded to the direction of the applied force. For example, we could see the glenoid fossa migrating mesially if a force such as

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that used in Class II cases was employed, and we could see the glenoid fossa migrating distally if the intermaxillary elastics were used in the opposite direction. All other parts like condyle, ramus, and angle showed similar behavior.

2. In jumping the bite, characteristic bone transformations in analogous regions appeared, accompanied by extensive traumatic changes in the tissues surrounding the roots, and the roots of the teeth themselves.

3. Raising the bite in the incisal region, as effected by the use of the commonly known bite plane, produced extra-alveolar bone changes, namely: shallowing of the glenoid fossa, bone deposition on the posterior side of the ramus from the condyle down to the region near the mandibular angle, and bone resorption on the anterior side of the neck of the condyle and at the lower border of the mandible and mandibular angle.

All these findings and their probable implications have been reported in two articles by the author ("Bone Changes Resulting From Experimental Orthodontic Treatment,"[8] and "Objectives in Correcting the Mesio-Distal Relationship in Class II Malocclusion"[9]). The evidence was found in microscopic investigations but the changes observed were extensive enough to be visible to the naked eye after only several weeks of treatment. It was suggested that these extra-alveolar bone changes could be utilized for orthodontic purposes because it seemed likely that once we knew about them we might also find means of controlling them. Some additional suggestions will be given in this report, but these again are not to be regarded as final conclusions. The investigations are being carried further with the hope of obtaining more specific suggestions for orthodontic therapy.

METHOD

The methods used in the experiments to be described* were similar to those employed in the previous investigations. The animal experimented upon was again the *Macacus rhesus* monkey, with one exception adult female specimens weighing between seven and eleven pounds with permanent dentition complete except for the third molar. One experiment was performed on a younger animal with mixed dentition weighing six and one-half pounds. Plaster impressions were taken from each animal before and after treatment under anesthesia. The animals were anesthetized for every operation with a barbiturate anesthesia given subcutaneously. The period of time of the treatment and the appliances used for each experiment will be described. The animals were sacrificed after treatment and the regions of interest examined histologically in serial sections.

DESCRIPTION OF EXPERIMENTS

The following group of related experiments will be described:

I. Raising the bite in the incisal region by a flat plane.
II. Raising the bite in the incisal region by an inclined plane.
III. Raising the bite in the molar region.
IV. Raising the bite in the incisal and molar regions consecutively.
V. Closure of the bite subsequent to extraction of molars.

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*The experiments were carried out with the assistance of the Orthodontic Division (Dr. Leuman M. Waugh, director) of the School of Dental and Oral Surgery of Columbia University, New York. The histologic material was prepared in the Department of Oral Histology (Dr. Charles F. Bodecker, chief).

I. Raising the bite in the incisal region by a flat plane.—Fig. 1*A* shows a cast of the original dentition of the animal; the appliance used appears in Fig. 1*B*. At first glance the appliance does not resemble a bite plate as used in humans, because a removable appliance cannot be employed in a monkey. In its place a cast metal cap with a plane was cemented on the maxillary incisors and canines. Obviously this apparatus influences the teeth to which it is cemented, in contrast to the removable plates covering the palate which are used in humans. The action, however, on the occluding mandibular incisors and canines and on the position and shape of the mandible is analogous to the action of removable plates used in humans. The animal was sacrificed five weeks after the placing of the appliance. The gross result is visible in Fig. 2 which shows the final plaster cast. Histologic investigations were performed on mandibular incisors, maxillary and mandibular molars and temporomandibular joint and the mandibular bone itself. The results on joint, angle and mandibular bone proper, in other words, the extra-alveolar bone changes, corresponded to the findings of the earlier analogous experiment referred to in the introduction. (They were: shallowing of the glenoid fossa, bone deposition on the posterior side of the ramus from the condyle down to the region near the mandibular angle, and bone resorption on the anterior side of the neck of the condyle and at the lower border of the mandible and mandibular angle.) A diagram of these changes is shown in Fig. 3.

Fig. 1.

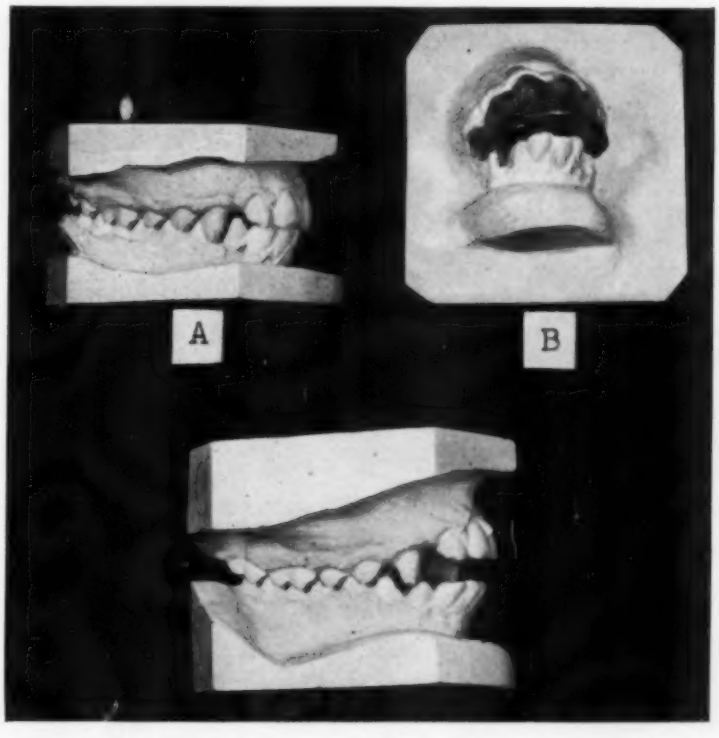

Fig. 2.

Fig. 1.—*A*, Animal I, original cast. *B*, Appliance used. See also Fig. 8.
Fig. 2.—Animal I, final cast.

The probable reasons for the rapid appearance of these bone transformations have been given in a mechanical analysis of the action of the anterior bite

plane.[8] The examination of the alveolar processes which had been omitted in the former investigation showed by bone deposition and resorption that the incisal teeth hitting the plane were slightly depressed, and that the molar and premolar teeth which through the bite plane had lost contact with their antagonists revealed little evidence of migration (elongation). Histologic evidence of the findings may be found in Figs. 17 to 19.* The significance of these findings will be discussed later.

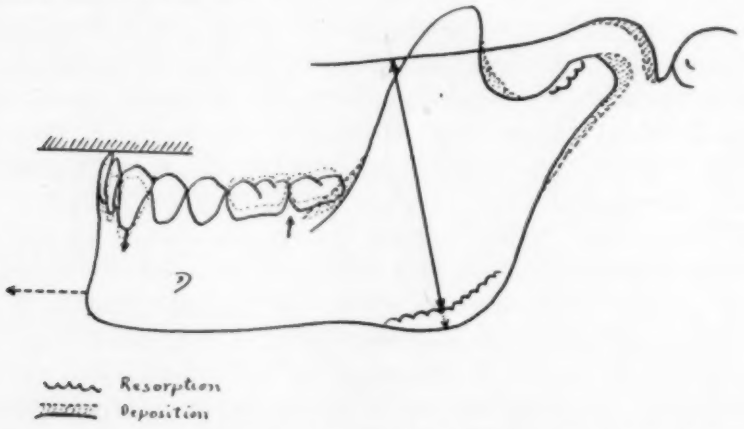

Fig. 3.—Diagram illustrating the effects of a flat plane in the incisal region.

Fig. 4.—*A*, Animal II, original cast. *B*, Final cast. *C*, Appliance used.

II. Raising the bite in the incisal region by an inclined plane.—A cast of the original dentition of the animal is shown in Fig. 4*A*. Fig. 4*C* shows the appliance used. It again differs in gross appearance from the removable inclined plane used in humans. The latter is usually applied in cases of distoclusion of the mandible and therefore lies behind the maxillary incisors. In the animal, however, we started with a normal occlusion and the inclined plane therefore lies directly under the maxillary incisors. The gross result is shown in Fig. 4*B*. Histologic investigation of the corresponding regions shows bone

*Lack of space prevents the reproduction of much histologic material.

transformation similar to that produced by the flat plane, but a difference may be found in the degree of the effect on the mandibular incisors. These teeth were influenced not only in an axial direction but also by virtue of the inclination of the plane were pushed labially, in other words, suffered lateral strain. This influence on the teeth exerted by the inclined plane is comparable to the effects of jumping the bite which have been discussed in earlier reports.[8, 9] The increased influence on the teeth themselves reduces the period of time of potential treatment and therefore probably decreases the effects on the joint and mandible proper. However, the bone transformations found in the joint and at the angle indicate changes in the shape and position of the mandible, the extent of which seems to surpass that of the changes produced by a horizontal plane in the same period of time. Histologic evidence will be found in Figs. 20 to 24.

Fig. 5.

Fig. 6.

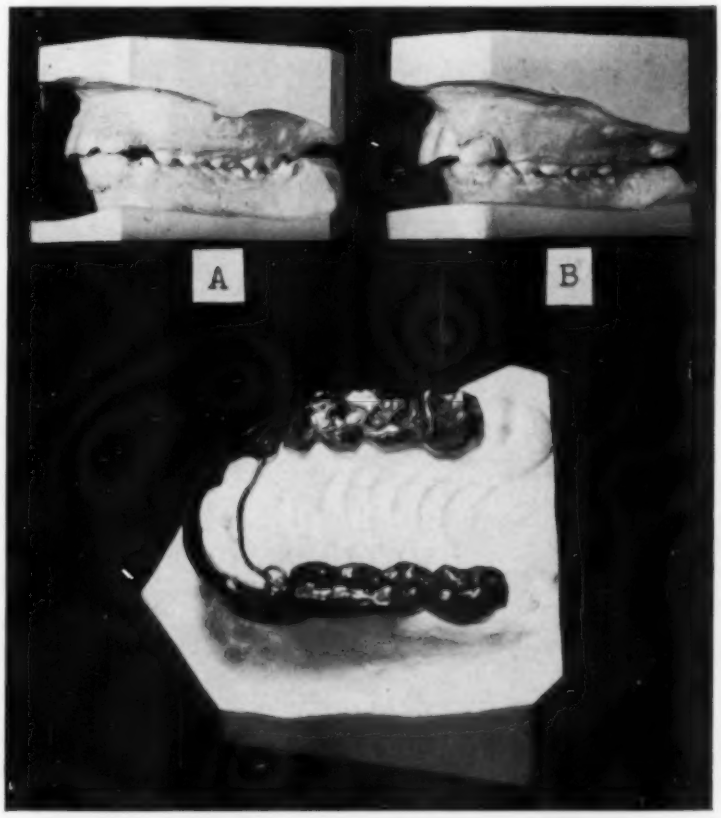

Fig. 5.—*A*, Animal III, original cast. *B*, Final cast. Note increased overbite (closure of bite) after three weeks of treatment.

Fig. 6.—Animal III, appliance used.

III. Raising the bite in the molar region.—The cast of the original dentition of the animal is shown in Fig. 5*A*. The appliance used was a metal cap covering the maxillary lateral teeth from first molar to canine. (Fig. 6.) The maxillary incisors were pushed out of the way by a lingual auxiliary spring. The bite-closing result after three weeks of wearing this cap is shown in Fig. 5*B*. Histologic examination demonstrates depression of the occluding maxillary

and mandibular molars and some traumatic changes around these teeth. The effects on the temporomandibular joint, ramus, body and angle of the mandible are similar to those obtained by raising the bite in the front region. Therefore we conclude that extra-alveolar bone transformations produced by raising the bite in the front region are produced as well by raising the bite in any region. This fact assumes practical importance: First, it opens the way for understanding and treatment of so-called open-bite. Second, it is important to note that the forward thrust caused by anterior plates is also induced by raising the bite in the molar region. These implications will be thoroughly discussed. Histologic evidence of the findings will be found in Figs. 25 and 26.

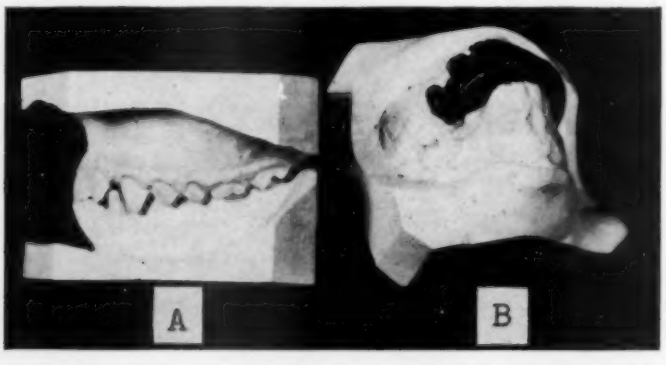

Fig. 7.—*A*, Animal IV, original cast. *B*, First appliance used.

Fig. 8.—Animal IV, flat bite plane in situ.

IV. Raising the bite consecutively in the incisal and molar regions.—This experiment was performed to test the hypothesis expressed in a previous paper[8] that by raising the bite first in the incisal and subsequently in the molar region, the position of the mandible in the skull may be changed without the application of intermaxillary forces. It was suggested that the mandible may be repositioned in a more mesial location by the described procedure, and the facial

contours (chin) thus affected to the maximum degree. Fig. 7*A* shows the original dentition of the animal. The first appliance used was a flat plane in the incisal region (Figs. 7*B* and 8). The condition after four weeks of use of this appliance is shown in Fig. 9*A*. A bite-raising splint, shown in Fig. 10, was then cemented in the molar region and after another period of forty-nine days the animal was sacrificed. The final gross result is shown in Figs. 9*B* and 11. The mandibular molars now bite about two millimeters mesial from

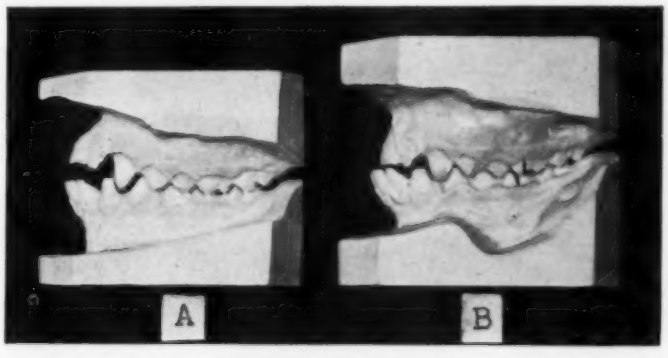

Fig. 9.—*A*, Animal IV, result of flat plane. *B*, Final cast.

Fig. 10. Fig. 11.

Fig. 10.—Animal IV, splint in situ.

Fig. 11.—Animal IV, gross result after removal of second appliance. Marked mesial occlusion of the mandible.

the original normal position, and upper and lower incisors show a definite prognathic (Class III) relationship. Histologically we found extra- and intra-alveolar bone transformation (Figs. 27 and 28) comparable to those produced in the other bite-raising experiments. The practical implications are obvious. The experiment proves that by such treatment a reshaping and repositioning of the mandible in a more mesial position can be effected without the use of intermaxillary elastics and therefore without any movement of teeth from their alveoli. In this way the maximum esthetic effect may be obtained in selected cases. The gross result of the experiment is not entirely satisfactory inasmuch

as there seems to be more forward movement of the incisors than of the molars. Two mistakes made in the experiment are responsible. (They were not realized at the time when the experiment was being carried out.) The first is that the mandibular incisors did not hit the plate at a right angle and therefore were somewhat tilted labially. (This action is comparable to that of the guide plane.) The second and more important mistake which prevented the molars from coming forward more than they did was that the posterior cap was not a flat plane but had cusps and grooves. The importance of this point will be discussed. (See Fig. 32.)

V. Extraction of molar teeth with subsequent closure of the bite.—In an adult animal all maxillary molars and premolars were extracted, leaving only the six front teeth in occlusion. The condition of the animal after these extractions is shown in Fig. 12. Four weeks after the first extractions the animal was sacrificed. From histologic examination of the occluding incisors it can be demonstrated that the vertical dimension was decreased due to the mutilation. The maxillary incisors show evidence of labial movement by bone resorption labially and deposition lingually (fanning of the incisors). The mandibular incisors show slight signs of depression. The temporomandibular joint shows characteristic changes which can be explained by physical pressure on the condyle against the posterior wall of the glenoid fossa. Both this posterior wall and the posterior side of the condyle show signs of bone resorption. It is remarkable that the bone destruction after four weeks is so extensive that it can be observed with the naked eye. No characteristic changes could be found at the angle.

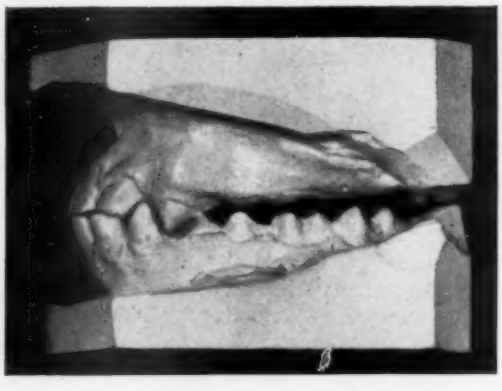

Fig. 12.—Animal V, cast after extraction of maxillary lateral teeth.

Histologic evidence for these findings is given in Figs. 29 to 31. The implications which are of importance for prosthetic dentistry as well as for orthodontics are discussed later. (See diagram Fig. 13.)

DESCRIPTION OF HISTOLOGIC MATERIAL

A former publication[8] contained several photomicrographs obtained from untreated *Macacus rhesus* monkeys (control animals). Since these pictures

were derived from young, growing animals, three microphotographs taken from adult control animals are presented here. Fig. 14 shows the mandibular angle of an adult animal. *B* represents the outer border of the mandibular bone at the angle. This border runs in a smooth line from left to right through the entire picture, covered by periosteal connective tissue (*P*). In all subsequent pictures of the same region of animals in which the bite was raised, we find the

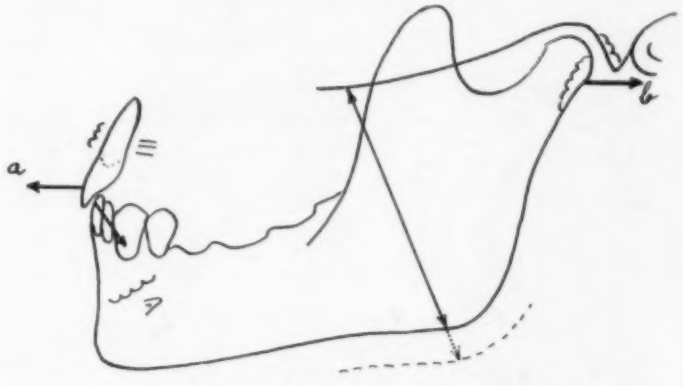

Fig. 13.—Diagram of the effect of loss of molar support. *a*, Labial movement of maxillary incisors. *b*, Pressure against posterior wall of glenoid fossa.

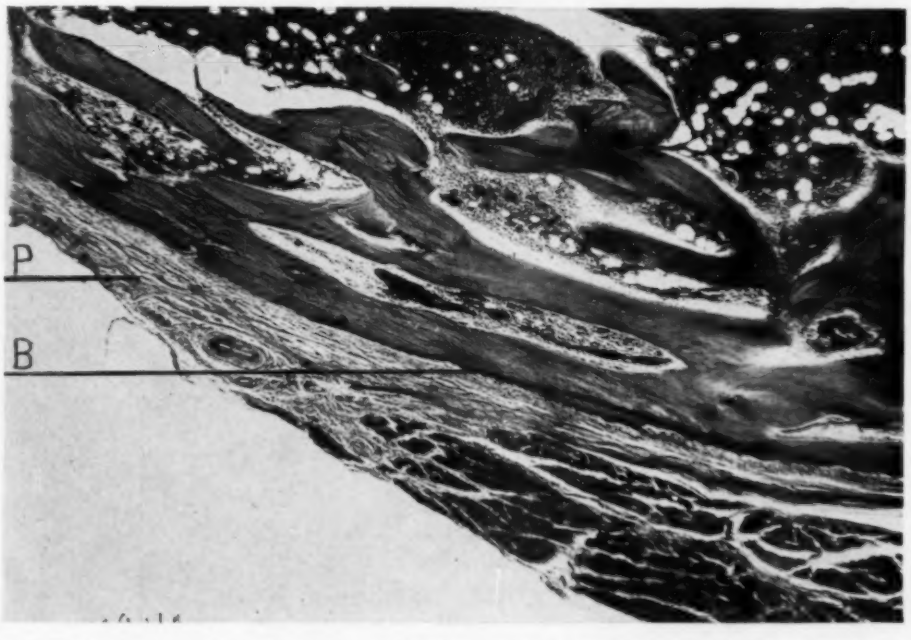

Fig. 14.—Control animal, region of mandibular angle. *P*, Periosteal connective tissue. *B*, Border of the mandibular bone.

outer border of the mandible serrated (resorbed) and giant cells (osteoclasts) scattered along it. Fig. 15 represents the temporomandibular joint of a control animal. Here again no bone changes are taking place. *D* is the intra-articular disk, *F* the posterior wall of the glenoid fossa, and *C* the cartilagenous lining of the head of the condyle. Fig. 16 shows in somewhat higher magnification the anterior wall of the head of the condyle (which showed resorption in

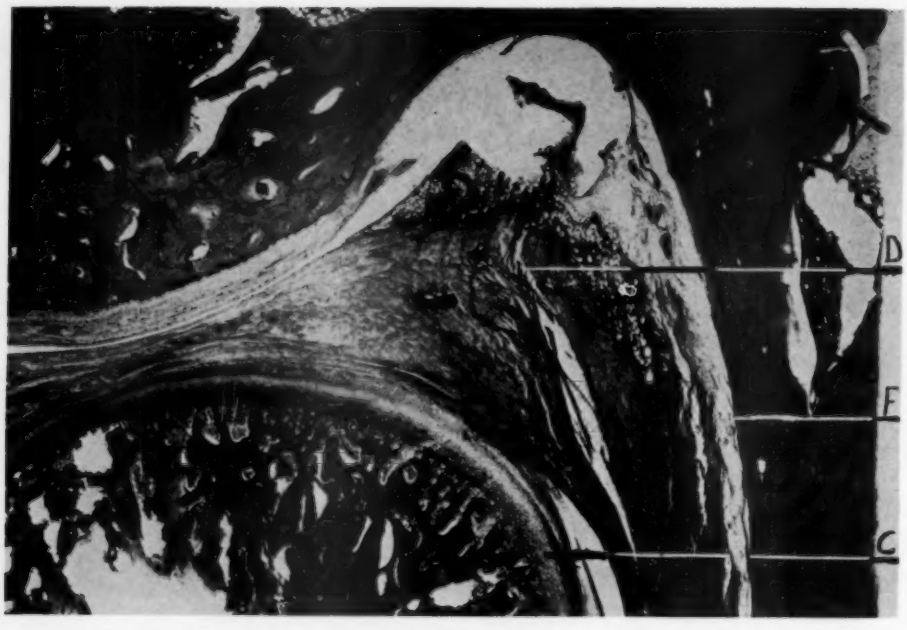

Fig. 15.—Control animal, temporomandibular joint. *D*, Intra-articular disk. *F*, Posterior wall of the glenoid fossa. *C*, Cartilagenous lining of the head of the condyle.

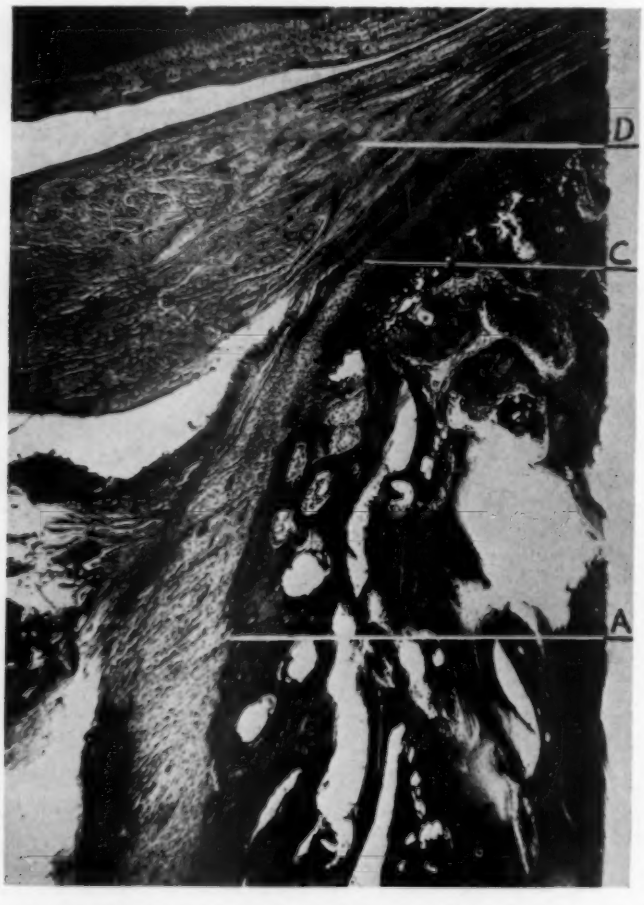

Fig. 16.—Control animal, anterior wall of head of the condyle. *D*, Disk. *C*, Cartilage. *A*, Anterior border of bone of the head of the condyle (no active bone changes).

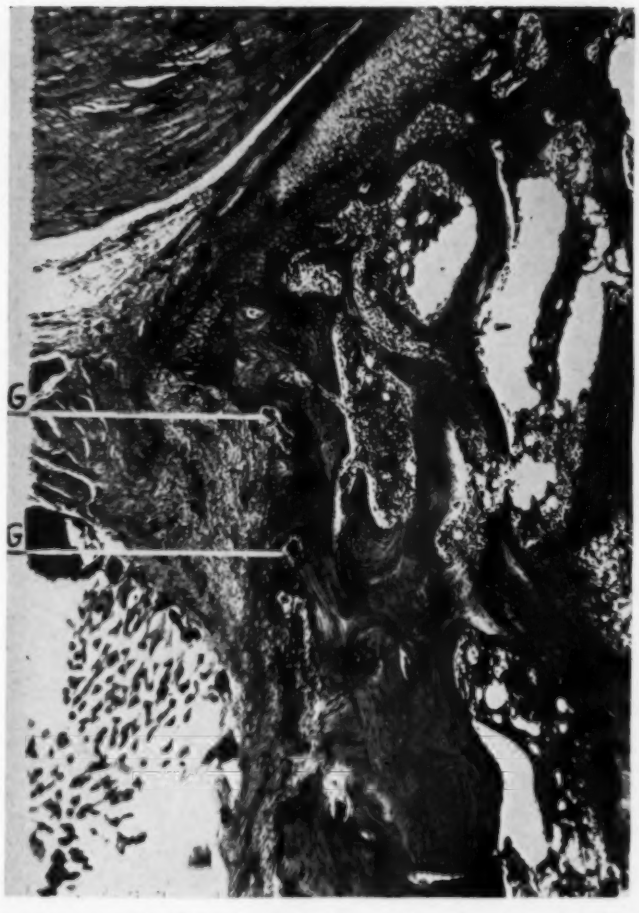

Fig. 17.—Animal I, anterior wall of the head of the condyle. *G*, Giant cells in Howship's lacunae. These cells and the serrated border of the bone indicate active resorption.

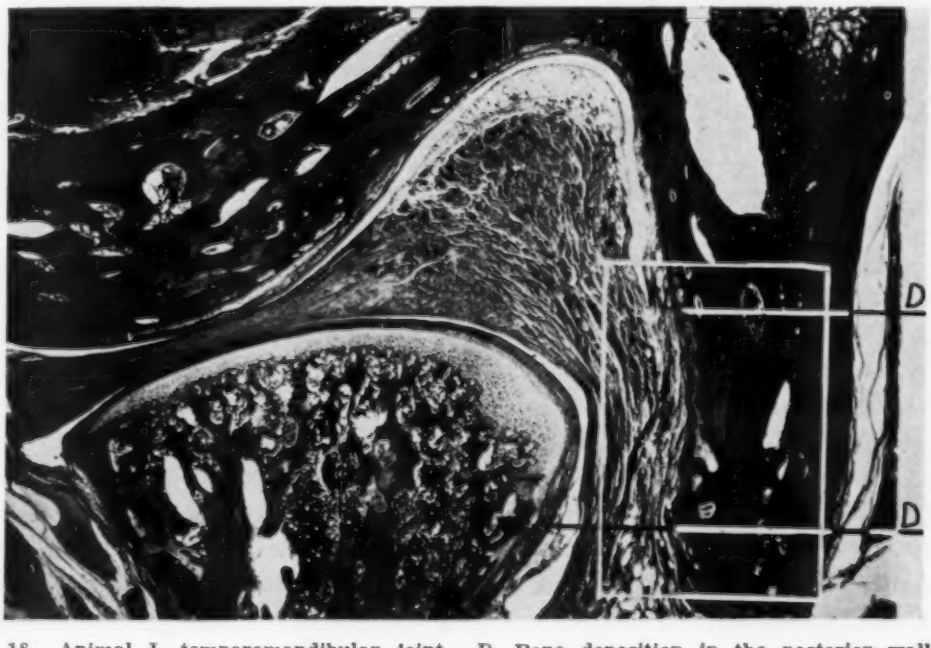

Fig. 18.—Animal I, temporomandibular joint. *D*, Bone deposition in the posterior wall of glenoid fossa and condyle.

all treated animals). In this control animal, as in other untreated animals, the anterior wall of the head of the condyle (*A*) shows no active changes. *C* is the cartilagenous lining of the head of the condyle, *D* the intra-articular disk.

Fig. 19.—Animal I, alveolar bone at the bifurcation of a nonoccluding molar. Note wide marrow spaces as compared with Figs. 25 and 28 (same magnification).

Figs. 17 to 19, inclusive, are derived from animal I in which the bite was raised by a flat plane in the incisal region. Fig. 17 shows the anterior wall of the head of the condyle. The surface of the bone is ragged, and giant cell (*G*) in Howship's lacunae indicate that the bone is being dissolved by resorption. Fig. 18 shows a sagittal section through the temporomandibular joint of the same animal. The glenoid fossa is lined with new bone, particularly at the posterior wall and at the depth of the fossa. Deposition of new bone (*D*) can also be noticed at the head of the condyle. Bone resorption around the roots of the mandibular incisors particularly at the apex shows that these teeth were depressed into the alveolar process. Fig. 19 represents the bone between the roots of a mandibular molar of this animal. The molar was prevented from occluding during the experiment. There are no characteristic changes visible, but comparison with analogous pictures taken from occluding or overloaded molars shows significant differences, inasmuch as the alveolar bone supporting

the nonoccluding molar shows larger marrow spaces and less density of the bony structure. (Compare the small marrow spaces and denser bone in Figs. 25 and 28.)

Figs. 20 to 24, inclusive, are taken from animal II in which an inclined plane was employed. A glance at the sagittal section of the temporomandibular joint photographed in Fig. 20 shows new bone trabeculae (*B*) at the posterior wall of the glenoid fossa. Similarly, Fig. 21 shows new bone formation (*B*) at the posterior wall of the head of the condyle. Figs. 22 and 23 show the lingual and labial plates of the incisal alveolar bone near the alveolar crest. Fig. 22, the lingual, reveals extensive deposition of new bone (*B*) lined by osteoblasts, while Fig. 23, taken from the labial side, shows giant cells (*G*) in Howship's lacunae, indicating resorption of bone. Together the pictures can be taken to indicate that the mandibular incisor hitting the oblique plane at an angle of about 45 degrees was moved from its alveolus in a labial direction. Fig. 24, taken at the mandibular angle of this animal, shows the characteristic serrated margin of the bone indicating resorption.

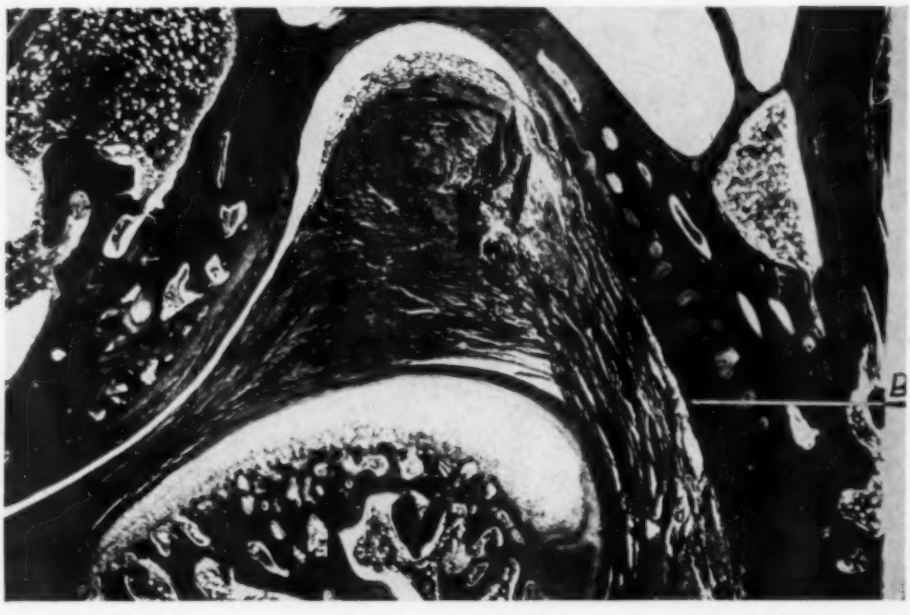

Fig. 20.—Animal II, temporomandibular joint. *B*, Bone deposition at the posterior wall of the glenoid fossa.

The next two pictures, Figs. 25 and 26, are taken from animal III in which posterior bite-raising caps were employed. This animal (mixed dentition) was younger than the others. Figure 25 shows the alveolar bone under a mandibular molar at the bifurcation. The molar tooth hit the caps cemented to the maxillary lateral teeth. As a result of the increased stress we note additional layers of cementum (*C*) and resorption (*R*) of the alveolar bone directly under the bifurcation (increased width of the periodontal space). Where the stress was not applied at a right angle to the periodontal membrane, as, for instance, along the roots (to the left in the picture), the periodontal membrane is not increased in width, and the trabeculae of the alveolar bone are arranged parallel to the

direction of the force. The marrow spaces throughout the alveolar bone are narrowed. This and the parallel arrangement of the trabeculae, as well as the increased thickness of the cementum indicate adaptation of the alveolar bone to the increased stress exerted upon the tooth. Likewise, the apical region of the same tooth shows new bone formation. The findings in the tissues of a young animal around a molar tooth under extraordinary stress, in a direction parallel to the long axis of the tooth, indicate that under these circumstances the tooth-supporting apparatus is not damaged nor destroyed. To the contrary, adaptation of the tooth-supporting apparatus to the increased stress takes place.

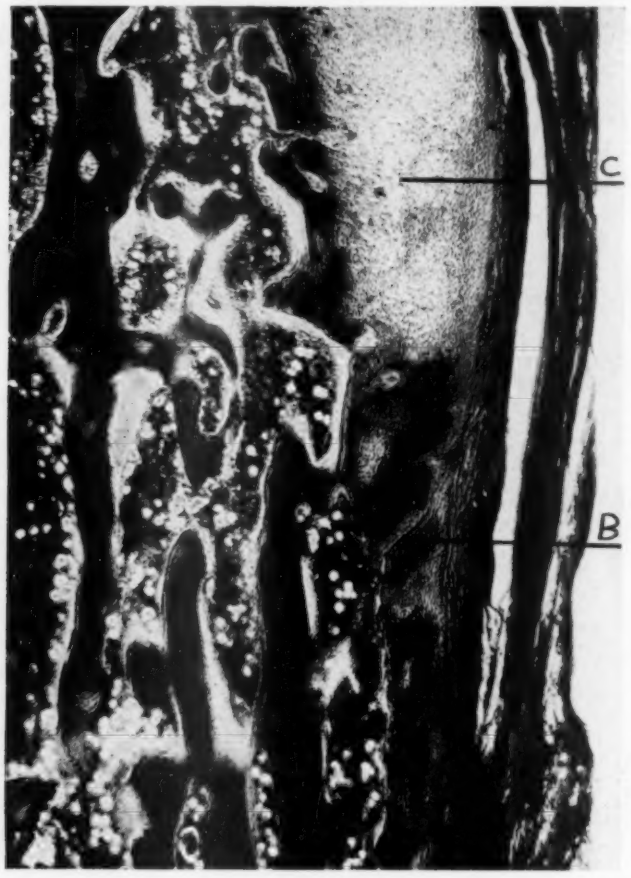

Fig. 21.—Animal II, posterior wall of the head of the condyle. *C*, Cartilage. *B*, New bony trabeculae.

Where, however, additional stress is imposed on a tooth in a direction not parallel to the longitudinal axis, quite different reactions are known to occur. Such lateral forces (compressing the periodontal membrane) lead readily to resorption of the alveolar bone and migration of the tooth. The implications of the difference in effect between forces applied in the direction of the long axis of the tooth and forces applied at an angle to that axis will be discussed. Briefly, the increased resistance to forces applied in the direction of the long axis of the tooth seems to enable the operator to apply relatively strong forces to the teeth in this direction, and to transmit forces through this increased resistance of the

alveolar bone to extra-alveolar areas. Lateral forces applied to the teeth will, on the other hand, produce extensive bone resorption and migration of the teeth themselves. The intensity of the forces which can be applied in a lateral direction without damage is therefore greatly limited, and so will be the possibility of transmitting such forces to extra-alveolar areas. Fig. 26 represents a region at the mandibular angle of animal III. The serrated margin indicates resorption as a result of the bite-raising effect of the caps.

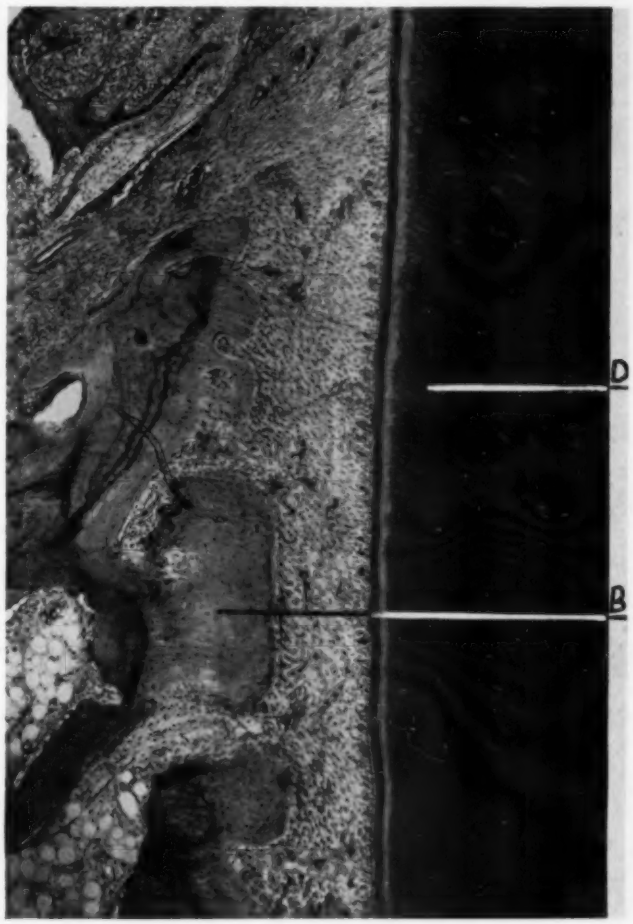

Fig. 22.—Animal II, lingual side of mandibular incisor. *D*, Dentine. *B*, Newly formed bundle bone.

Figs. 27 and 28, inclusive, are taken from animal IV in which anterior and posterior raising of the bite were employed consecutively. The temporomandibular joint did not show any evidence of bone changes at the moment of sacrifice. It is suggested that this be attributed to the fact that the second bite-raising appliance (the posterior splint) was not constructed with a flat surface, but had grooves and cusps interdigitating with the opposing teeth. As will be pointed out later, such interdigitation counteracts the forward thrust of the mandible attributed to flat bite-raising planes (see diagram Fig. 32). Fig. 27 shows a region at the angle of the mandible, again indicating resorption in this area. The mandibular molars wore the bite-raising cap until the sacrificing of

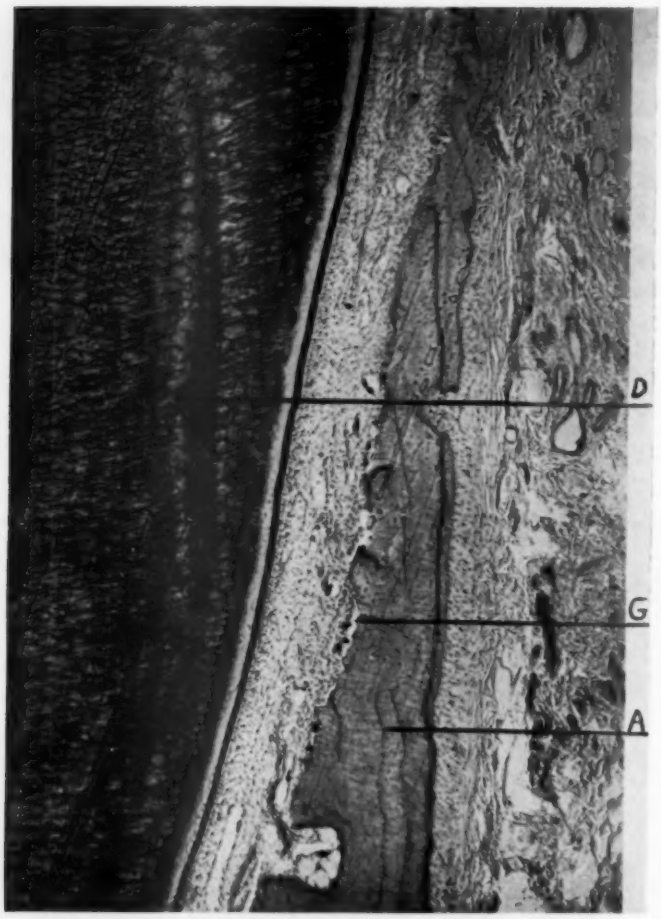

Fig. 23.—Animal II, labial side of mandibular incisor. *D*, Dentine. *G*, Giant cells. *A*, Labial alveolar plate.

Fig. 24.—Animal II, region at the angle of the mandible (bone resorption).

Fig. 25.—Animal III, alveolar bone at the molar bifurcation. *A*, Alveolar bone. *D*, Dentine. *C*, Cementum (increased in thickness). *R*, Connective tissue replacing resorbed bone. Note parallel arrangement of alveolar bony trabeculae and increase in density (narrower and fewer marrow spaces). Compare Fig. 19.

Fig. 26.—Animal III, region at the angle of the mandible (bone resorption).

Fig. 27.—Animal IV, region at angle of mandible (bone resorption).

Fig. 28.—Animal IV, alveolar bone at the molar bifurcation. *R*, Resorption. *A*, Alveolar bone (very few marrow spaces). *C*, Resorption of cementum. Compare Fig. 19.

the animal. The alveolar bone at the bifurcation of such a molar is shown in Fig. 28. The picture resembles Fig. 25, in that we see lessening of the bone marrow and increased density of the bone and also resorption (*R*) at the top of the arch of the bifurcation. However the width of the cementum is not increased and we see resorption of the cementum at *C* reaching into the dentine, whereas the cementum of the younger animal responded with hyperplasia to the increased stress.

Fig. 29.—Animal V, anterior side of head of condyle. *R*, Resorption.

Figs. 29 to 31, inclusive, are obtained from animal V, in which the maxillary lateral teeth were extracted. A labiolingual section of an upper central incisor shows characteristic changes. The lingual alveolar bone shows formation of new bundle bone while resorption of the labial plate takes place. The findings indicate that the central incisor was in a state of labial migration, probably as a result of closure of the bite resulting from the extraction of the molars.* Fig. 29 shows the anterior wall of the head of the condyle which is being resorbed (*R*). Fig. 30 shows similar resorption at the posterior side of the head of the condyle (*R*) and Fig. 31 again shows resorption (*R*) at the posterior wall of the glenoid fossa. The evidence of resorption at the posterior wall of the fossa and the posterior wall of the head of the condyle indicate backward pressure of the head

*Lack of space prevents the reproduction of these photomicrographs.

of the condyle toward the posterior wall of the glenoid fossa. It should be noted that these bone transformations which are obviously results of loss of molar support could be observed only three weeks after extraction. The mandibular angle significantly showed no evidence of bone changes.

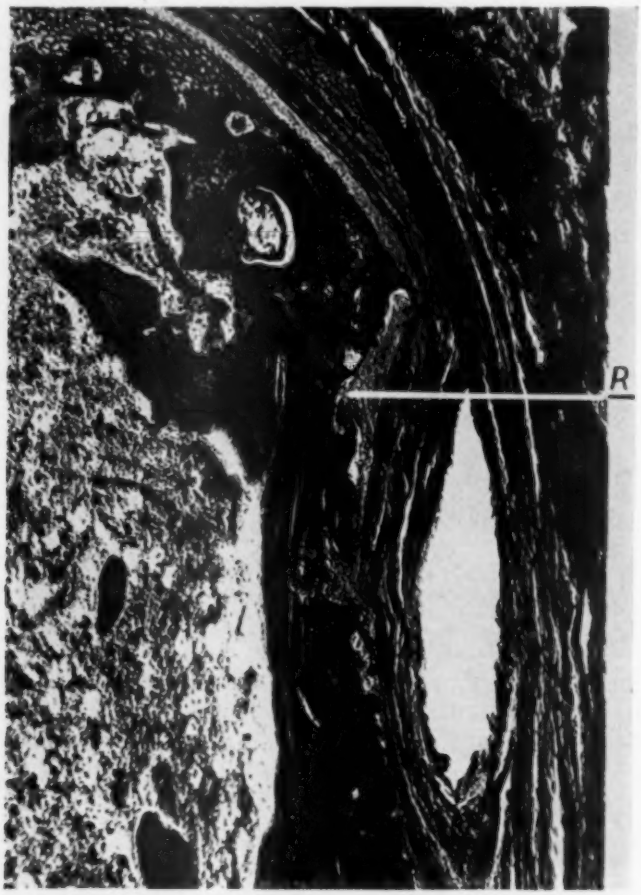

Fig. 30.—Animal V, posterior side of head of condyle. *R*, Resorption.

DISCUSSION

General Considerations

Five experiments have been described in which change of the vertical dimension was induced in various ways. In all of these experiments bone transformations could be noted not only in the alveolar process, but also in other bony parts. These bone transformations seem to indicate that any artificial change of the vertical dimension not only influences the alveolar processes but also leads to changes in shape and position of the mandible. The bone transformations subsequent to raising of the bite might be regarded as nature's intention to re-establish the original vertical dimension and, with it, the balance between muscular action and architecture of the bone. There is evidence in clinical experience as well as in the experimental material that such a balance exists in all stationary cases, both normal and pathologic. This opinion has previously been expressed by Strang.[10] We may therefore consider any effort to alter the status

of a masticatory apparatus (in other words, any orthodontic treatment) as an effort to disturb this balance with the intention of creating bone changes in a desired direction.

This hypothesis was offered and elaborated in an earlier article by the author.[9] Practitioners and investigators have recognized the tendency of the vertical dimension to re-establish itself after bite-raising interference. John Mershon[11] explains the situation clearly when he writes, "Bone, although hard, is the most plastic of the body tissues. . . . As correlation in growth takes place, the adaptive change is always in bone, never in muscle. Bone is the passive tissue, muscle the active tissue. . . . Muscle is dominant. . . . Therefore, the other tissues change and adapt themselves until the muscles are relieved of all strain."

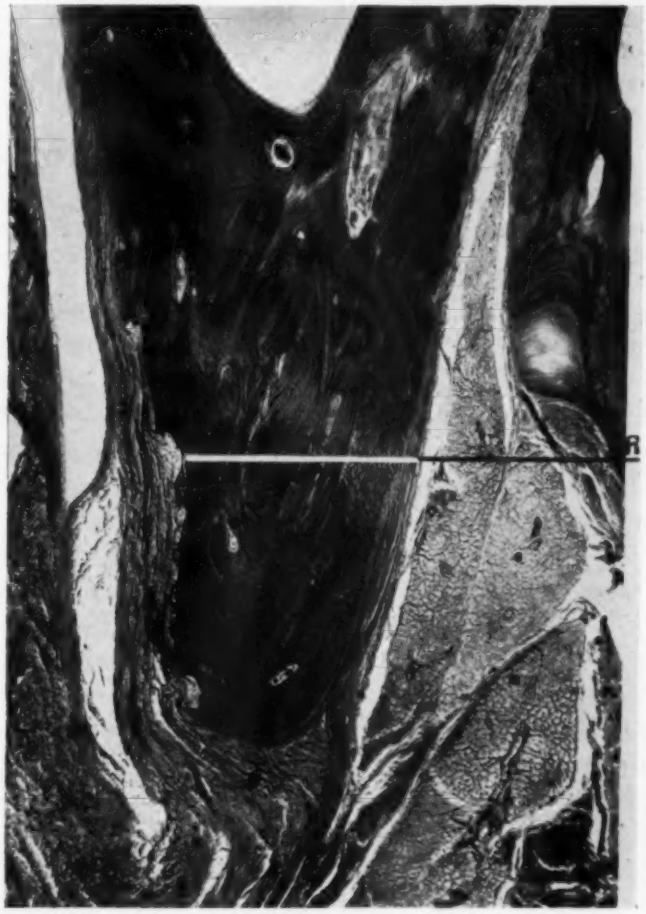

Fig. 31.—Animal V, posterior wall of glenoid fossa. *R*, Resorption.

Mershon then reports his futile efforts to raise the bite permanently by prosthetic procedures. He found that the vertical dimension re-established itself in a very short time, and his experience has been duplicated by that of many practitioners. The bone changes which lead to the return of the vertical dimension to its original value do not, however, occur in the alveolar processes only. Histologic evidence shows that important adaptations of the bone occur also in

extra-alveolar areas. *It is therefore suggested to attempt utilization of these extra-alveolar bone transformations for orthodontic purposes.*

The vertical dimension in a given individual can be considered the result of the balance between the muscular tone and the architecture of the bone. Muscular tissue is much less subject to induced changes than bone tissue, and particularly the length of the masticatory muscles in a given individual seems to be comparatively constant after development. Since bone tissue, although hard, is the most plastic tissue in the body, it is the shape of the bony structure which yields after artificial change of the muscular action, to allow the re-establishing of the original vertical dimension and, with it, the original muscular length. The bone transformations found in the histologic material indicate this adaptation of the bone toward re-establishing the original muscular length.

This hypothesis is true of any effort to increase the vertical dimension above the original value, i.e., raising the bite. *While, however, the vertical dimension cannot be permanently increased above the original level, in cases of previous closure of the bite the original height may be re-established by restorations.* It also seems possible to decrease the vertical dimension, e.g., by extraction of teeth. Loss of molar support, in animal V, led to closure of the bite, and corresponding bone changes around the remaining teeth and in the temporomandibular joint could be noted after three weeks.

These considerations of the vertical dimension contain important implications for prosthetic dentistry and may assume importance for orthodontic therapy. In accordance with the hypotheses offered, the following explanation of the *action of bite-raising appliances* is submitted: We know that the normal individual has a so-called "rest position" of his jaws. In this rest position all forces acting on the hard tissues of the masticatory apparatus are in balance with one another, e.g., the tone of the masticatory muscles balances the tone of the mouth-opening muscles; the tone of the facial muscles and air pressure in the oral cavity are counteracted by the tongue and air pressure in the nasal passages, etc. In other words, in the rest position the mandible remains in a position in which all forces applied to it offset one another. This rest position is continuously maintained when the teeth are not in function. It is characteristic of this rest position that maxillary and mandibular teeth are not in contact with one another. If we increase the length of one or several teeth artificially by fixed or removable appliances, the affected teeth will come in contact with their antagonists in the rest position, or even make that rest position physically impossible. These elongated teeth will therefore be under constant pressure, as will their antagonists, and it is this constant pressure which represents, to the author's thinking, the action of bite-raising appliances. To repeat, according to this theory, it is the constant, involuntary pressure exerted on elongated teeth during the greatest part of a 24-hour day, and not the maximum pressure exerted sporadically by active contraction of the masticatory muscles which creates bone changes. If the latter were true, the man who eats more or chews harder would depress his teeth. In addition, Boos[12] has found that the masticatory muscles are capable of exerting the maximum force at the normal vertical dimension (working position). An increase of the vertical

dimension would therefore not increase the maximum power of the muscles. (We know that we feel more masticatory power in crushing a small object than in cracking a large one.) This theory that the action of bite-raising appliances is due not to the intermittent maximum power of the masticatory muscles but rather to the constant slight pressure exerted upon the teeth coming in contact in the rest position agrees with clinical experience. Bite-raising appliances show quickest results if worn constantly day and night and, according to the author's experience, it makes little difference in the efficacy of the appliance whether the patient wears it during his meals. In fact, in order to obtain proper mastication and thus maintain good nutrition it is suggested that patients be advised to remove bite plates during meals, but only then.

Here another problem enters: *How can raising the bite affect extra-alveolar areas?* The forces released by a bite-raising appliance act primarily upon the teeth and can be transmitted to jawbones and skull only via the tooth-supporting apparatus. It is an interesting finding of the experiments that in some instances, after changes of the vertical dimension, the intra-alveolar bone changes are not more but rather less extensive than the changes found in the temporomandibular joint, condyle, ramus, etc. We might expect more action in the alveolar processes since the forces applied to the teeth are certainly considerably stronger than the forces exerted by routine orthodontic appliances such as archwires and springs. The prevalence of extra-alveolar bone changes can, however, be explained, in corroboration of clinical experience: The strong forces released by bite-raising appliances act in a direction parallel to the longitudinal axis of the teeth; the tooth-supporting apparatus is physiologically designed for stress in this direction. We may assume, in fact, that the texture of the alveolar bone becomes denser and more resistant under the additional stress in the proper direction. (See Figs. 22, 28, and 33.*) It has also been demonstrated by MacMillan[13] and by Gottlieb and Orban[14] that the alveolar bone surrounding a functioning tooth contains many more trabeculae than the bones surrounding a tooth which has lost its antagonist. MacMillan writes,[13] "When a tooth is under increased occlusal stress, the bone is physiologically adapted to take care of that increase. . . . In the absence of other systemic causes of periodontoclasia, the physiologic adaptation of the alveolar process around the tooth . . . is such that the increased occlusal stress is met by an increased closeness of spacing of the cancellous tissue, denoting a compensatory strengthening of the area under stress. . . ."

Gottlieb and Orban[14] conclude from their experiments: "The absence of functional stress reduces to a minimum the trabeculae lying behind the "true" alveolar process. Should functional stress be restored, the structural formation of the spongy bone is reinforced."

Thus, after the initial shock of the force, the alveolar process becomes more resistant and through this resistance permits the transmission of the forces to extra-alveolar regions.† A clinical example may support this theory which has

*Since this report was delivered, an article by B. Orban[16] has been published in which he writes: "In all discussions on traumatic occlusion, cusp interference, raising the bite, etc., it should be kept in mind that the supporting structures of the teeth are built to withstand much force and load if applied along the long axis of the teeth."

†This holds true only where the force applied is parallel to the longitudinal axis of the tooth; in other words, where the tooth hits the bite-raising appliance at a right angle.

been deduced from histologic findings. A flat plane in the front region often produces a space of several millimeters between maxillary and mandibular incisors within a few weeks. Yet the occluding lower incisors are usually found neither sensitive nor loose. This phenomenon could not be explained if this space obtained in such short time were due to alveolar bone changes. A space of several millimeters in the front region may rather be the result of much less extensive bone changes at the angle and temporomandibular articulation. Raising the bite in the molar region clinically usually produces slight sensitivity of the molars for the first one or two days. This is understandable. The molar teeth lie directly within the line of action of two strong masticatory muscles (internal pterygoid and masseter), while, to the incisors, the forces are transmitted via the mandibular body which acts as a lever, increasing the motion but decreasing the force.

Practical Implications

The fact that any change in the vertical dimension produces intra- and extra-alveolar bone changes carries practical implications for prosthetic dentistry as well as for orthodontic treatment. The practitioner of prosthetic dentistry may draw his own conclusions from the material presented. We want, however, to point out:

1. It does not seem imperative to construct prosthetic restorations according to present conditions of the temporomandibular joint, but rather to realize that this organ will adapt itself in a very short time to a given occlusion.

2. From the experimental findings after extraction of molars we may deduce an explanation of the discomfort experienced by patients after closure of the bite. Pressure of the condyle toward the posterior wall of the glenoid fossa is probably responsible for this phenomenon.

3. The establishing of centric relation (condyle in fossa) in edentulous cases is possible only at the presented (edentulous) vertical dimension. Weeks or months after extraction of teeth the vertical dimension presented by the patient does not coincide with the original value, which the prosthodontist usually wants to re-establish. Hence it is not only difficult but practically impossible to establish centric relation at the original vertical dimension many weeks after extraction. Here the construction of immediate dentures offers a solution.

For the orthodontist, the first and most important implication is that his *field of endeavor is not confined to the alveolar processes.* Routine orthodontic appliances may act predominantly in this region, overshadowing extra-alveolar changes,* but the results of the experiments suggest that in changing the vertical dimension a means might be given to the operator of producing bone transformations in remote areas. In other words, a means of reshaping and repositioning the mandible proper, with all its inherent advantages, may emerge.

From Experiment IV, in which anterior and posterior bite raising was applied consecutively, we derive a point which bears upon the construction of bite-raising appliances in general. The procedure followed in the experiment

*Because they usually impose lateral forces on the teeth.

proved actually to be a means of repositioning the lower dental arch more mesially without moving the teeth from their alveoli. (See Figs. 7, 9 and 11.)

It has been suggested in a former paper[8] why raising the bite means creation of a forward thrust of the mandible. This applies to raising the bite in the incisal region as well as in the molar region. There is, however, a detail of importance involved. The forward thrust of the body of the mandible can be expected only if smooth, flat planes are used. If cusps or incisal edges of the oposing teeth are caught in grooves of the plate, the teeth will be held in their mesiodistal relation and the forward thrust of the mandibular body will be reversed, at least partially, into a backward thrust of the head of the condyle. (See diagram, Fig. 32.) This backward thrust will then produce bone resorption on the posterior wall of the glenoid fossa and the posterior side of the condyle. Such resorption has been observed histologically.* Teeth which are caught in opposing grooves and thus prevent the forward thrust of the mandible from materializing suffer (in addition to strain in an axial direction) lateral stress which induces yielding of the alveolar bone. It therefore is essential, if we want to utilize the forward thrust of the mandible caused by raising the bite, to employ only smooth, flat bite-raising surfaces. When Experiment IV was performed the importance of this principle was not realized while constructing the posterior plate. Therefore the result in the molar region and in the position of the entire mandible is not so satisfactory as it could have been. The experiment is being repeated with a flat posterior plane. Conversely, if we want to maintain the mesiodistal relationship of the jaws, bite-raising appliances, if necessary, should be constructed with grooves in which the opposing teeth are caught.

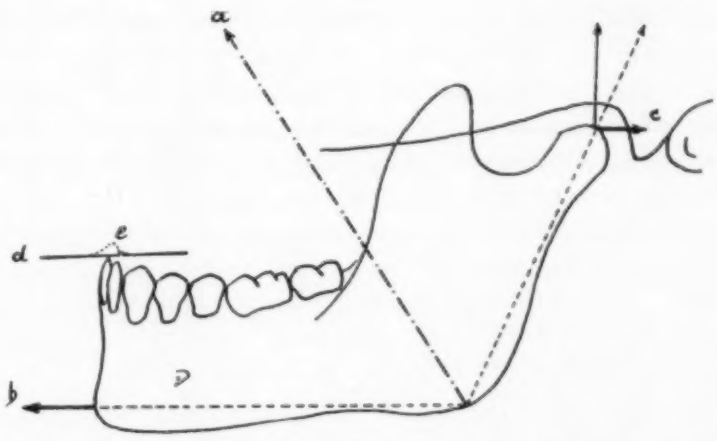

Fig. 32.—Diagram illustrating the importance of flat, smooth surfaces in bite-raising appliances, if forward thrust of the mandible is desired. Force *a* (increased muscular pull) creates forces *b* and *c*. If a flat plane (*d*) is applied the mandible will slide forward along it. If the incisors are caught in grooves (*e*) the effect of force *c* will materialize.

The comparative success of the experiment, although not performed under ideal conditions, encourages the attempted use of this type of procedure on humans wherever it seems advisable to move not only mandibular teeth but also the chin forward. This type of treatment can, of course, also be combined with the use of intermaxillary forces.

*It can be observed in all cases where forward thrust of the mandible is counteracted by the occlusion with the opposing jaw.

The whole procedure applied in this experiment is a good example of how a change of the shape and position of the mandible via temporary changes of the vertical dimension might be induced. The vertical dimension will return to its original value with a new, more mesial position of the lower dental arch.

After consideration of the results of Experiment III in which a posterior bite-raising appliance was employed, the following suggestions in regard to the anomaly commonly known as *open-bite* may be ventured. In this condition only a few of the posterior teeth occlude with their antagonists, and in extreme cases only two or four teeth bear the entire load of occlusion. We know that a bite opened artificially in this way by restorations (high crowns, too high inlays, etc.) would soon return to its original height, presumably by depression of the few occluding teeth and elongation of the nonoccluding ones. Therefore we have been puzzled by the fact that in open-bite cases the few occluding teeth remained permanently at their level. Among other explanations offered, a pathologic condition of the bone (sclerosis) has been held responsible. Treatment by elongation of the incisors has been tried, but seemed not always to assure a full success in severe cases. Considering the results of the experiments, we felt that the vertical dimension presented in open-bite cases was the proper one for the particular individual. In other words, it was the vertical dimension given by the muscular length in correlation with the structure of the individual's bone. The same teeth which, although bearing the entire occlusal forces, were not depressed without interference would, therefore, so we supposed, soon be depressed if the vertical dimension was increased. That is, they would be depressed if the bite was raised in the region of the occluding teeth. Such procedure has successfully been applied in the orthodontic clinic of Columbia University.

In cases of deep overbite we deal with relatively underdeveloped molars. To correct this we are accustomed to raise the bite in the incisal region. In cases of open-bite we deal with relatively underdeveloped incisors. It therefore seems logical to attempt correction of this condition by raising the bite in the molar region. Such procedure will temporarily open the bite additionally in the incisal region. After re-establishment of the original vertical dimension, the gap between maxillary and mandibular incisors with the appliance in situ will be as large as it was originally without the appliance. Removal of the appliance, now, will bring about reduction or elimination of the incisal gap.

The experiment proved the validity of this theory. Animal III, wearing posterior bite plates, developed a deep overbite after three weeks. In other words, the bite was closed in the front region, and this is what we need for correction of the open-bite. (See Fig. 5.)

A corroboration of the theory that the open-bite as well as the deep overbite is the result of a disturbance between the bony structure and the muscular forces applied to it may be found in a clinical observation of Max J. Futterman.[15] This author regularly observed in cases of pseudohypertrophic muscular dystrophy a definite type of dental anomaly associated with open-bite. The degenerative changes in the muscular tissue characteristic of this disease are probably responsible for the dental anomaly.

Investigations and experimental studies of the subject of the open-bite are being carried further.

If we should succeed in inducing extra-alveolar bone changes at will in desired areas through temporary changes of the vertical dimension, we should obtain the following advantages:

1. Extra-alveolar bone changes are essential to changes in the facial outlines.

2. Extra-alveolar bone changes could be produced in a comparatively short time because the bone transformations necessary to re-establish the original vertical dimension are clinically known to occur rapidly.

3. Results obtained through extra-alveolar bone changes might tend less toward relapse since such changes might be induced by artificial change of the muscular function rather than by exogenous forces (such as springs or elastics) which must be eliminated after treatment.

Further experimentation and practical application will disprove or corroborate the theories submitted in this report.

SUMMARY

Previous histologic investigations of experimentally treated animals have furnished evidence that the influence of orthodontic treatment is not limited to the alveolar processes but extends to other areas, causing bone transformations in the temporomandibular joint, ramus, body and angle of the mandible.

In an effort to determine the relation of these extra-alveolar bone changes to changes in the occlusion, a new series of experiments has been conducted.

Various experiments are described in which an artificial change of the vertical dimension was attempted. These experiments, as well as those previously reported, show that attempted changes in the vertical dimension encourage extra-alveolar bone transformations in addition to those in the alveolar processes.

Almost all occurring bone transformations can be explained if we assume that artificially elongated muscles tend to re-establish their original length, and succeed in attaining it by adaptation of the bone.

The vertical dimension of a given individual appears to be the result of an equilibrium among all forces (active and resisting) present in the masticatory apparatus. The vertical dimension can therefore be permanently decreased by mutilation of the hard tissues, but it cannot be permanently increased above its original value (except, perhaps, by weakening of muscular tissue).

The forces created by raising the bite are probably transmitted to extra-alveolar areas by increased resistance (adaptation) of the alveolar bone to excessive stress in a direction parallel to the long axis of the tooth. Raising the bite artificially will therefore cause bone transformations within and without the alveolar processes, with the ultimate result of re-establishing the original muscular length and the original vertical dimension. The bone transformations necessary to re-establish the original vertical dimension might possibly be utilized for various orthodontic purposes, such as influencing the facial contours, or closure of open-bite.

The exploitation of changes within the alveolar processes produced by various appliances has long been the basis of orthodontic treatment. The results of the experiments encourage the attempted exploitation of extra-alveolar bone changes as well.

I wish to express to Dr. Leuman M. Waugh and to Dr. Charles F. Bodecker of the School of Dental and Oral Surgery of Columbia University my deep gratitude for lending so generously their efforts and facilities to make this investigation possible. I should also like to thank Dr. Moses Diamond for his stimulating encouragement.

REFERENCES

1. Sandstedt, C.: Einige Beitrage zur Theorie der Zahn regulierung, Nordisk Tandlare Tideskrift, No. 4, 1904, Nos. 1-2, 1905.
2. Oppenheim, A.: Tissue Changes Particularly of the Bone, Incident to Tooth Movement, Tr. European Orthodont. Soc. **8**: 11, 1911.
3. Gottlieb, B., and Orban, B.: Die Veranderungen der Gewebe Bei Ubermassiger Beanspruchung der Zahne, Leipzig, 1931, Georg Thieme.
4. Kronfeld, R.: Practical Orthodontia, Chap. II, Tissue Changes Incident to Orthodontic Tooth Movement, Dewey-Anderson, St. Louis, 1935, The C. V. Mosby Co.
5. Marshall, John A.: A Study of Bone and Tooth Changes Incident to Experimental Tooth Movement and Its Application to Orthodontic Practice, INT. J. ORTHODONTIA **19**: 1, 1933.
6. Stuteville, O. H.: A Summary Review of Tissue Changes Incident to Tooth Movement, Angle Orthodontist, January, 1938.
7. Case, C. S.: Dental Orthopedia, C. S. Case Co., Chicago, 1921, page 82.
8. Breitner, C.: Bone Changes Resulting from Experimental Orthodontic Treatment, AM. J. ORTHODONTICS AND ORAL SURG. **26**: 521, 1940.
9. Breitner, C.: Objectives in Correcting the Mesio-Distal Relationship in Class II Malocclusion, Angle Orthodontist, October, 1940.
10. Strang, R. H. W.: A Textbook of Orthodontia, Philadelphia, 1933, Lea & Febiger.
11. Mershon, J.: Bite-Opening Dangers, J. A. D. A. **26**: 1772, 1939.
12. Boos, R. H.: Intermaxillary Relation Established by Biting Power, J. A. D. A. **27**: 1192, 1940.
13. MacMillan, H. W.: The Clinical Significance of Disuse Atrophy of the Alveolar Process. J. A. D. A. **14**: 697, 1927.
14. Gottlieb, B., and Orban, B.: Biology and Pathology of the Tooth and Its Supporting Mechanism, New York, 1938, The MacMillan Company.
15. Futterman, Max J.: Dental Anomalies Associated With Pseudohypertrophic Muscular Distrophy, Dental Outlook, February, 1940.
16. Orban, Balint: Biologic Considerations in Dentistry, J. A. D. A. **28**: 1069, 1941.

ADDITIONAL REFERENCES

Breitner, C.: a, Experimentelle Veranderung der Mesiodistalen Beziehungen der Oberen und Unteren Zahnreihen, Ztschr. f. Stomatol. **28**: Heft 2 and 7, 1930; **29**: Heft 4, 1931; b, Die Wirkung der sogenannten Gaumenplatte, Ztschr. f. Stomatol. **30**: Heft 19, 1932.

Callaway, G. S.: Use of Bite Plates, AM. J. ORTHODONTICS AND ORAL SURG. **26**: 120, 1940.

Futterman, M. J.: a, Dental Anomalies Associated With Pseudohypertrophic Muscular Dystrophy, Dental Outlook, February, 1940; b, Inefficient Mastication, J. Second Dist. Dent. Soc. **25**: 381, 1940.

Hemley, S.: Bite Plates: Their Influence on Growth of the Mandible, J. A. D. A. **26**: 1829, 1939.

Hopkins, S.: Bite Planes, AM. J. ORTHODONTICS AND ORAL SURG. **26**: 107, 1940.

McLean, D. W.: The Physiology of Mastication, J. A. D. A. **27**: 226, 1940.

Orban, B.: Biologic Problems in Orthodontia, J. A. D. A. **23**: 1849, 1936.

Schwarz, A. M.: Tissue Changes Incidental to Tooth Movement, INT. J. ORTHODONTIA **18**: 331, 1932.

BEHAVIOR OF NORMAL AND ABNORMAL FACIAL GROWTH PATTERNS

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INTRODUCTION

ONE year ago, in Chicago, I had the privilege of presenting before this Society the results of investigations at the University of Illinois in the field of normal head growth.[2] Over the last ten years considerable material on abnormal growth was being collected, but until the past year there has been little opportunity to study it. Various graduate fellows and students have been working on such widely separated fields as normal and abnormal jaw movements,[9] the spatial relationships of the mandible, hypothyroidism,[5] facial proportions, and the relationship of various teeth to the face and head.[1, 4] Investigations on normal[8] and abnormal growth of the teeth have been going forward in Dr. Schour's department, and such conditions as anodontia, congenital syphilis, and other types of hypoplasia have been investigated there.[7] An effort has been made to integrate these diverse studies in this presentation.

PRINCIPLES IN GROWTH

We have found that a study of the teeth sheds a great deal of light on the general principles of growth. These structures, unlike bone, cannot be modified once they are formed and calcified. If a growing animal is injected with alizarin red S the parts of a tooth or a bone that are being deposited at that time will be stained red. In the case of the teeth this stain results in a thin red line which will never be lost. By giving multiple injections over a period of time one obtains, in a cross section cut from such a tooth, a series of lines. If measurements are made between these lines, a number of important principles in appositional growth can be elucidated. From such studies new light has been shed on the principles of growth, and a better understanding of these principles has given valuable clues in studies on deformed growth. I should therefore like to explain a few points about the growth of the teeth before considering normal and abnormal facial growth.

Following fertilization of the ovum the only discernible process is cell multiplication. This is at first not accompanied by any apparent differentiation. Even after the future body has begun to take on a nonspherical form, that is, to assume polarity and bilateral symmetry, the cells still seem to be alike. Experimental work with transplants, however, proves beyond any reasonable doubt that the surface has now become a series of "fields," or differentiated areas, each predestined to give rise to its own particular tissue or organ. These fields are organized around centers, which points mark the earliest and greatest activity. Ultimately the cells begin to show visible signs of differentiation and from now on they can no longer be influenced away from their given tasks.[10]

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Presented before the Great Lakes Society of Orthodontists, Oct. 28, 1940, the Chicago Association of Orthodontists, March 31, 1941, and the American Association of Orthodontists, May 5 to 8, 1941.

All of these preliminary steps, as well as those succeeding them, can be beautifully demonstrated in studies of the teeth. We shall start with the instant of initiation when the epithelial cells on the surface of the alveolar crests begin to increase in number in certain areas (Fig. 1). Downgrowths occur at ten places in each jaw, indicating the beginning of the deciduous teeth. At the end of each downgrowth the cells enter a stage of marked proliferation which

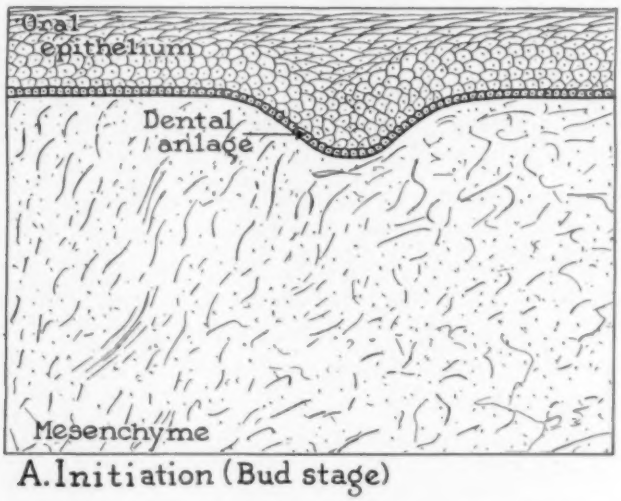

Fig. 1.—Diagrammatic representation of odontogenesis. Stage of initiation in tooth formation. (Schour and Massler, *J. A. D. A.* 27: 1778, 1940.)

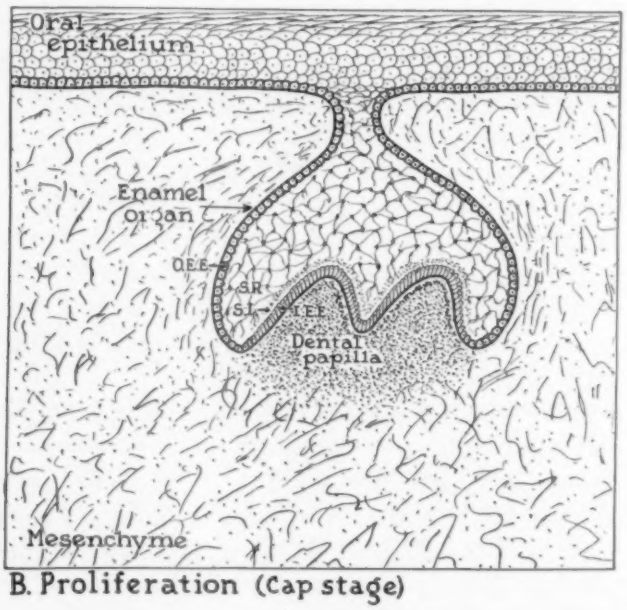

Fig. 2.—Stage of proliferation in tooth formation. Underlying mesenchymal tissue is condensed to form dental papilla. (Schour and Massler, *J. A. D. A.* 27: 1778, 1940.)

ends only after multitudes of new cells have been formed and have arranged themselves in a cuplike form (Fig. 2). Now proliferation ceases, and cell differentiation begins. The innermost cells of the cap take on a columnar form and exhibit typical nuclear and cytoplasmic changes. This activity on the part

of the ectodermal cells appears to call forth typical and peculiar responses in the mesodermal cells with which they are in contact. (This occurs commonly whenever and wherever such ectoderm is brought in contact with mesoderm.) The mesodermal cells undergo differentiation and arrange themselves like a row of blocks against the ectodermal cells (Fig. 3).

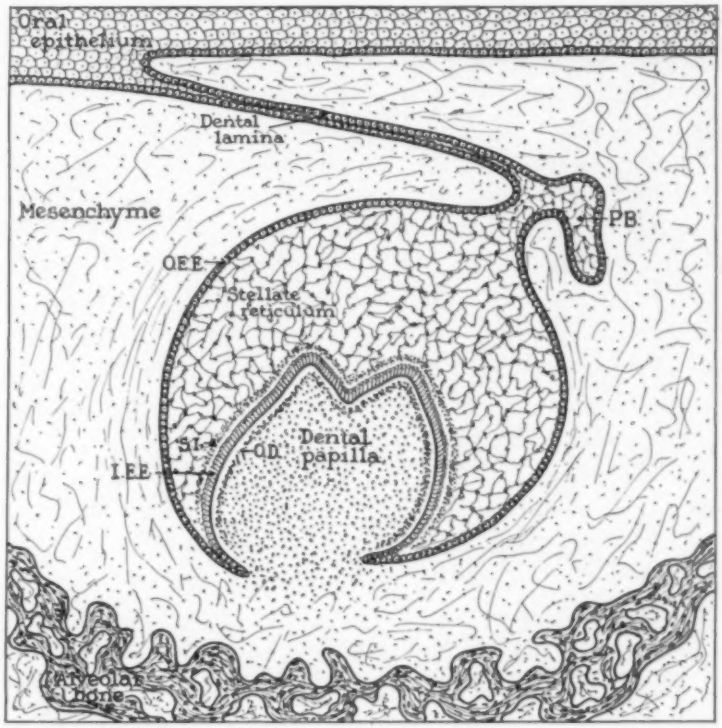

Fig. 3.—Stage of histodifferentiation. Proliferation ceases, outer cells become ameloblasts and inner cells become odontoblasts establishing dentino-enamel junction. Form is now established—morphogenetic stage. (Schour and Massler, *J. A. D. A.* 27: 1778, 1940.)

By the time the above stage of differentiation of cells is reached the entire accumulation of cells has taken on a pattern or form which reveals the tooth that it will give rise to, and henceforth this form will not change. This is called the morphogenetic stage, or morpho-differentiation, and the plane of junction between the ectodermal and mesodermal cells represents the future dentino-enamel junction. In short, the blueprint of the future tooth has been drawn up. The analogy of a blueprint with workers following it makes for a clear understanding of the ensuing processes, and we shall therefore enlarge upon it. The workers in this case are the ameloblasts on the outer surface and the odontoblasts within. Both have become specialized for the laying down of the hard parts of the tooth, enamel and dentine, respectively.

Let us imagine a great number of bricklayers of all degrees of skill. They arrange themselves with the most experienced and skillful man in the exact center. Around him are grouped in a circle the next most skillful and around them a circle of a slightly lesser skill, and so on, until we reach the lowliest apprentices on the outmost rim.

At a given signal the chief workman starts to form his first brick (enamel globule), and it takes him all day to make and place it. It is the very largest brick he can make, working at his highest capacity. On the second day the circle of bricklayers immediately around him try to duplicate his performance but their bricks are not quite as large as his first one, since they are progressively less skillful. In a similar manner, the succeeding circles of workers take up their tasks and each group shows a slight decrease in size. Going back to the first workman, or the master, we find that the brick that he makes on the second day is not quite up to his first day's product and that each day shows a corresponding decrease in his effectiveness. In a similar manner, the other workers show a day by day decrease in their output, so that there is a tapering off from the center toward the periphery. But even this is not all. Just as man's life span is held fairly close to his preordained threescore years and ten, so is the life span of these cells limited—only much more strictly. When this limit is reached, the cell must stop work and that portion of the tooth is finished. Since the master worker was the first one to start work it naturally follows that the apprentices will be working for some time after he has finished.

Growth Gradients.—Now to recapitulate in more scientific terms, we may say that growth is always initiated at a definite center, and in the case of the tooth, this center marks the site of the future cusp tip. From this focal point growth spreads slowly toward the periphery (Fig. 4). We say we have a *locus gradient.* The cell at the center of the growth works at a higher rate than those immediately surrounding it, and the rate continues to fall as we go toward the periphery. This is a *rate gradient.* Next, we notice that all cells exhibit a maximum intensity at the beginning, with a gradual slackening as they grow older. This is an *age gradient.* And finally, all cusps, even in the same tooth, do not start simultaneously but rather in a definite sequence. We have a *time gradient.*

Let us try to grasp the significance of these findings. Let us suppose the teeth are acted upon by adverse factors during the various stages we have enumerated. If this occurs during the stage of initiation or, in other words, if initiation is prevented, we have anodontia or a complete absence of teeth. If it occurs during the time when activity is being localized at the sites of the future teeth, we will have an absence of only those teeth that are being budded off at the time. Obviously, overactivity at this time could lead to supernumeraries. During the stage of differentiation, or when the blueprint or dentino-enamel junction is being laid down, an adverse factor will express itself in distortion of form, such as peg laterals and the various distortions seen most frequently in mandibular second bicuspids.

From this point on nothing can alter the dentino-enamel junction or basic pattern of the tooth. The pattern of enamel and dentine apposition can be affected, however, and shows the effects in hypoplasias. The location and distribution of such defects depend on the time of activity and, knowing the chronology of tooth formation and calcification, we can accurately date the disturbance. Such disturbances occurring around the date of birth will mark the cusps of the first permanent molar only. Shortly after birth the molars and central incisors will be affected, still later these teeth and the canines, and at

about one year the maxillary lateral incisors will show defects since they begin to calcify about this time. We see from all of this that the *time* of activity of the adverse factor, rather than its nature, is the determinant of the effect. Sarnat[7] has shown that even the typical luetic or Hutchinson's tooth may well be attributable to the time of activity rather than to any specificity of the agent.

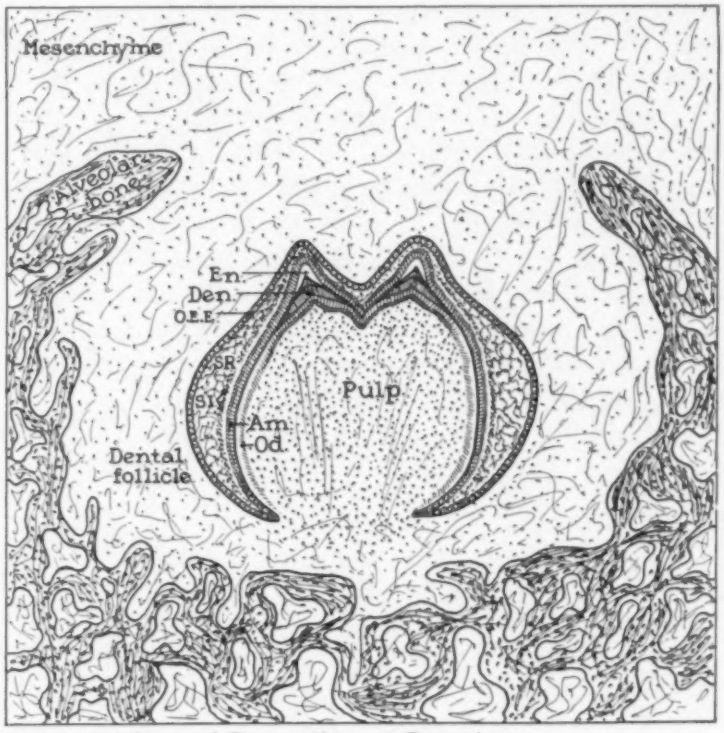

Fig. 4.—Stage of apposition. Enamel and dentine are laid down at cusp tips or growth centers and process spreads slowly towards periphery. Final form of tooth is a result of the operation of various gradients (locus, rate and time) on a dentino-enamel junction already laid down. (Schour and Massler, *J. A. D. A.* 27: 1778, 1940.)

The Skeletal System.—A careful study of skeletal growth shows that all of the foregoing principles hold true in regard to bones. We shall not concern ourselves here with the earliest or initiatory stages, but will begin with differentiation. As in the teeth, we find a general form or morphogenetic pattern laid down and specific cells assigned to build it up according to the same gradients. Some sites begin very early, work at a high rate of speed, and are finished when others are only beginning their labors. Thus, the cranium is complete in its parts fairly early in fetal life, whereas the wrist centers do not appear until relatively late in postnatal life. If we accept the principle that adverse factors can affect only those parts that are growing at that time, it follows that in skeletal growth we can have a *distortion* of pattern or form only at a time when all sites have not yet begun their work. As in the case of the teeth, there seems to be little or no specificity in the action of adverse factors. The same factor, acting at different ages, will give rise to quite different effects. Such a factor, acting while all centers are operating, will affect all and lead only to a generalized arrest. Local accidents to restricted sites can, of course, operate at any

time. I shall try to make this point clear as we go along, but it may be pointed out at this time that different parts of the body have attained different levels of development as early as the date of birth, when we find the head closest to the adult size, the trunk next, and the limbs least.

NORMAL GROWTH OF THE CRANIUM

In the newborn child we find a cranium that is closer to its adult size and proportions than any other part of the body. Its width has been most fully attained, with height next, and its length dimension lacking the most. But even when we examine this last item, viz., length, we find that it does not increase evenly. From about six years onward one can superpose x-ray headplates on the internal surface of the anterior cranial cavity and they will show practically no increase. Only the supraorbital region shows any marked increase in the outline of even the outer table. On the other hand, the posterior parietal and occipital areas show continuous growth, particularly of the outer surface, up until sixteen or eighteen years. Thus it would appear that growth ceases in front much earlier than in back.

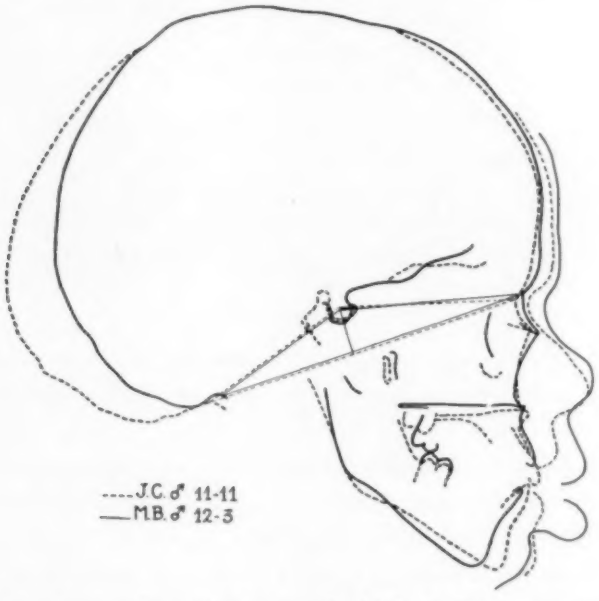

Fig. 5.—Superposition of two cretin patterns, one of which (J. C.) has received thyroid therapy. Note failure of parietal and occipital growth in untreated case. (Engel et al.)

The effect of this difference is illustrated most strikingly in cases of congenital hypothyroidism. The infant is thought to follow a perfectly normal course of development up until birth when he is suddenly deprived of his mother's thyroid hormone without having any of his own to take its place. Obviously this lack cannot reveal itself in parts that have almost completely attained their full size. The areas that suffer are those which still have considerable growth expectancy, namely, the occipital and parietal areas (Fig. 5). Only very early interference can bring about distortions of the frontal pattern of the head.

NORMAL GROWTH OF THE HEAD

There is an even greater differential between the cranium and the face. At birth the braincase is from six to eight times the size of the face, which means that it has grown much more rapidly in utero and also that it started earlier. It follows a curve that is typical of the growth of the nervous system. The face, on the other hand, although exhibiting an early spurt, reaches a point where its growth describes an even and orderly increase to adulthood.

X-rays of the face, unlike those of the cranium, do not seem to reveal differentials. The face appears to grow as a unit so far as its total pattern is concerned. Checking by means of vital stains, however, reveals that some sites contribute far greater percentages than do others, but all centers are so integrated that they lead to no changes in form. The illustrations will bear out this point.

Fig. 6.—Tracings of three stages of growth of a white male infant, from 3 months to 7 years. Note (1) the angular constancy in the descent of the nasal floor, occlusal plane and mandibular border; (2) the downward and forward movement of the anterior nasal spine, maxillary central incisor and chin point; (3) downward and backward progression of the mandibular angle; and (4) the straight downward course pursued by the posterior nasal spine and pterygomaxillary fissure.

Fig. 6 shows the pattern of growth of the head of a white male infant from 3 months to 8 years. The superpositioning is done on the sella-nasion plane, with the center of sella registered. It will be noted that the floor of the nose descends in a parallel manner, as does also the occlusal plane and the lower border of the mandible. The anterior nasal spine goes downward and forward on a straight line, as do also the maxillary central incisors and the chin point gnathion. The posterior nasal spine goes straight downward while the point at the angle, gonion, goes downward and backward.

When we glance at similar representations of growth in older age ranges, we do not find any place or time when this orderly process is changed. Thus the next figure, Fig. 7, portrays a child from 3 years to 10 years, the following one (Fig. 8) a subject that runs from 9 years to 16 years. The same even and steady behavior of the pattern is found in all. The only difference between

successional stages lies in the size of the increment. The operation of the age gradient results in a constant deceleration of growth.

But the x-ray, while giving us the best picture of the total amount and direction of growth, fails to tell us *where* growth is occurring. For this we must turn to other methods of investigation. At Illinois we have used injections of alizarin red S in living monkeys, and this method has revealed the principal sites of actual bone deposition in the face. I shall call attention to only a few of these in this presentation.

Fig. 7.—Tracings of two stages of growth of a white male child from 3 years to 10 years. Note continuation of same unchanging behavior as that shown in Fig. 6.

Fig. 8.—Tracing of white male child from 9 years to 16 years.

Growth Sites of the Maxilla.—It was seen in the serial x-rays that the middle face, or that part between sella-nasion and the occlusal planes, increases markedly throughout the entire growth span. This growth results in a lowering of the floor of the nose and of the occlusal plane. It seems to be brought about

principally by an *upward* growth of the maxilla proper and a downward growth of its alveolar process. The red stain is invariably found on the maxillary side of the zygomatico-maxillary suture, the floor of the orbit, and, in long-snouted animals, at the frontonasal suture. The maxilla is thus pushed downward by its own upward growth. In a similar manner the tuberosity grows backward against the pterygoid process of the sphenoid, thus pushing the maxilla forward. These two vectors yield the downward and forward resultant shown in the x-rays. In addition to all of this, the alveolar process gains considerable height by depositions on its free margins.

Growth Sites in the Mandible.—Since the body of the mandible is growing in height during all this time, and since it has been shown that the occlusal plane and the lower border of the mandible do not change their angular relations to the cranium or upper face, it follows that one of two things must happen: either the glenoid fossa in the cranial base must descend with the middle face or the mandibular condyle must grow upward at a rate that is equal to the sum of all vertical growth of the face. Alizarination reveals the latter to be the true condition. Not until after all of the teeth are in place and fully occluded do we fail to find the dye in the condyle. The free alveolar border is likewise very persistent in its growth but perhaps not so prolific.

The same method has shown that the early growth of the mandible is generalized and occurs on all surfaces. At the time of the eruption of the first permanent molar, however, growth comes to be restricted to certain areas. In the case of the body this is the alveolar border. If one dissociates the body of the mandible from everything else, including the ramus, he cannot avoid the conclusion that the teeth erupt almost vertically. Room for the permanent molars is gained by the resorption of the anterior border of the ramus. We may say that the greater proportion of growth of the body is vertical. When we turn to the ramus, the picture is quite different, since here we find our bone deposition on the posterior and superior borders exclusively. Thus the bone is made longer, anteroposteriorly, and the ramus is kept in proportion by the resorption of the anterior border referred to above. Thus we may say that the greater proportion of growth in this part is horizontal. Finally, we turn to the condyle and here we find upward and backward growth, and this growth is greater in amount than either of the others. Since this area is in contact with the cranium which has almost ceased its growth by this time, it can be seen that the result would be a downward and forward driving of the entire mandible as seen in the serial x-rays.

From all of the foregoing it seems apparent that the growth process in the normal individual is a steady one and that it is not accompanied by changes in form. To state it most simply, proportionality is maintained as indicated by the fact that all anatomic points travel on straight lines. Now, how does the abnormal or distorted pattern behave during growth?

ABNORMAL GROWTH

In previous reports it has been stated that no changes were discernible in Class II malocclusions during growth. In short, these anomalies seem to be

present at birth and are not the effect of either sudden environmental impact or of a long-continued habit such as mouth breathing (Fig. 9). Reviewing recorded cases of the past ten years, a number of different conditions were found in which records have been made over relatively long periods of time. I should like to report on several of these since their study strongly supports the principles we have already discussed.

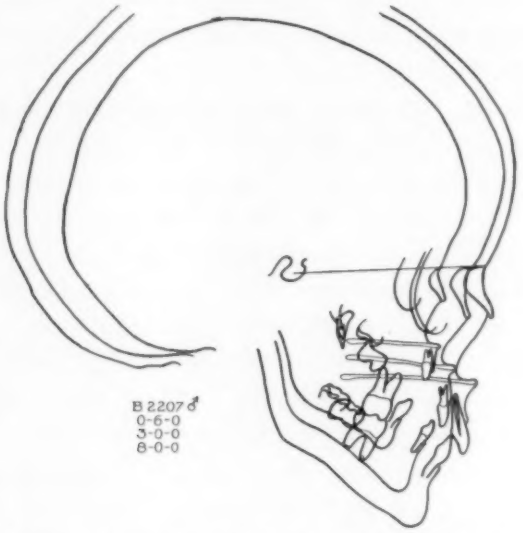

Fig. 9.—Tracings of three stages of growth in a child with a Class II, Division I malocclusion. Note that the pattern exhibits the same orderly behavior as that shown by the normal.

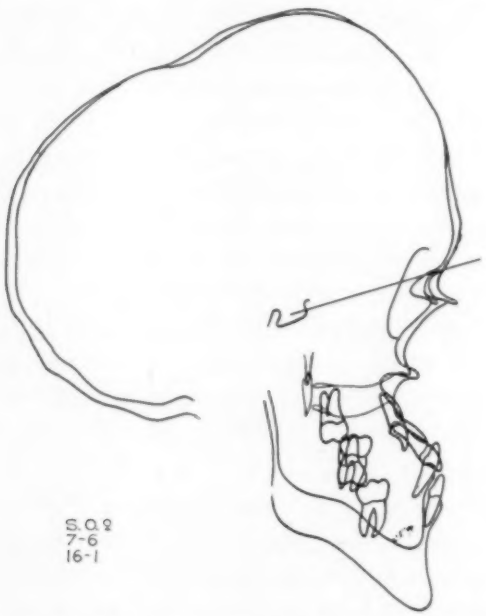

Fig. 10.—Tracings of growth pattern of patient with craniofacial dysostosis. Note lack of anteroposterior growth of cranium and face with increase in vertical dimension over 8½ year period.

Craniofacial Dysostosis.[3, 6]—The first case exhibits the distortion of craniofacial dysostosis, a congenital defect of the frontal area of the cranium (Fig. 10). It will be noted that the frontal area is abnormally high and that the anterior

cranial base is extremely short. This defect could only have occurred at a very early age since the growth centers involved have nearly completed their work at birth. In contrast to this, note that vertical dimensions have, if anything, been accelerated. The nasal floor, occlusal plane, and mandibular border have descended in the typical manner and to a normal degree. The face has grown down but has failed to grow forward since it is joined to a part that was affected by the disturbance.

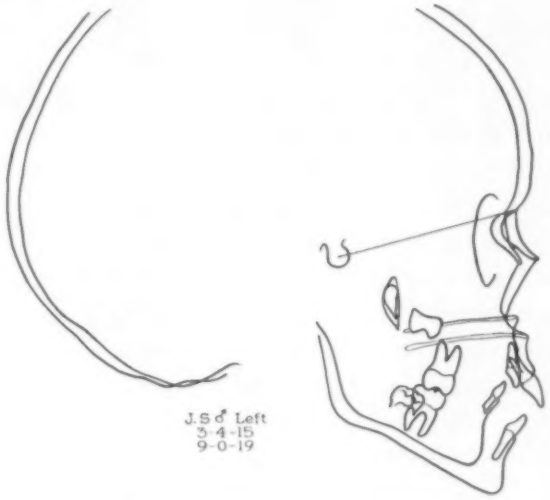

Fig. 11.—Tracings of growth pattern of patient with unilateral paralysis of fifth, seventh and eighth nerves. (Unaffected side.)

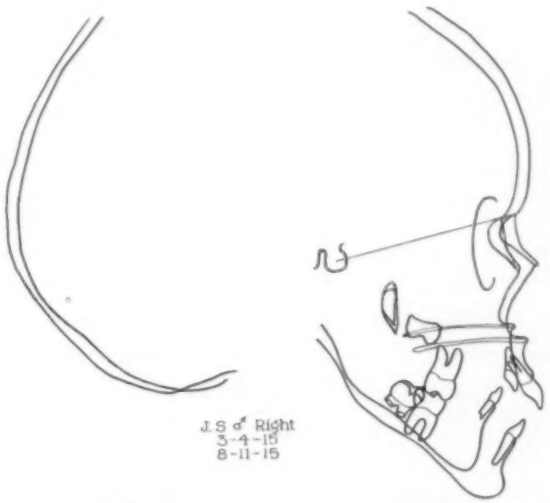

Fig. 12.—Tracings of affected side of patient shown in Fig. 11.

Paralysis.—The next case is one exhibiting a marked asymmetry of the face and cranium (Figs. 11 and 12). There is a unilateral paralysis of the fifth, seventh, and eighth nerves, so that the patient is deaf, insensitive over the facial area and unable to use the masticatory muscles on this side. The opposite side of the face, however, shows a perfectly normal development and if one were to restrict the examination to the profile x-ray of this side, he would be unable to detect any deviation from the normal in size, form, or rate of growth.

On the affected side we find that the mandibular angle is markedly flattened and the vertical height of the face thereby diminished. Strangely enough, however, the rate of growth seems to have been the same and equal to the normal side, and an examination of the patient reveals no deviation of the midline of the mandible. A review of the history of this case uncovers some very interesting information. The mother had a uterine tumor prior to conception. The child was delivered at full term by high forceps. The forceps were applied over the temporal area with considerable injury to the right side. One might wonder how three nerves could be injured in this manner. An x-ray of the base of the skull reveals a large opening in the area of the foramen lacerum. The tentorium is attached to the tip of the petrous part of the temporal bone and immediately posterior to this area the three nerves enumerated are in close apposition to each other. Excessive force applied on the temporal bone crushed the entire bone inwardly and, the tentorium proving stronger than the tip of the pars petrosa, the tip was broken off with injury to the nerves. I am informed by competent authorities that this is not a rare occurrence. One might assume at first glance that the flatness of the angle was also the result of this injury but such is not the case. It will be noted that the length of the ramus and the length of the jaw are both normal and that, furthermore, they have increased in size in the same amount as the normal side. In other words, the growth center at the head of the condyle has not been affected and the distortion of the angle is undoubtedly due to the pressure of the uterine tumor upon this point. The significant thing to be noted about this case is that in spite of the terrific injury there has been no effect on growth. The pattern, although markedly distorted, has continued to grow at a perfectly normal rate.

Micromandibular Development.—The next case (Fig. 13) is that of a girl whose condition is variously known as micromandibular development, Andy Gump chin or, in the European literature, Vogelgesicht. Upon ordinary examination this patient gives the impression of having no mental eminence, whereas x-ray examination reveals that symphysis height is much greater than normal. The ramus is abnormally short and the body appears to be bent down in the region of the notch just anterior to the angle. The bite is open. I have never seen one of these cases where other skeletal anomalies could not be demonstrated. These take the form of stiff joints of elbow, shoulder, or ankle, webbing of the fingers and other deformities usually classed as congenital. The illustration reveals the amount of change that was effected in this case over a course of treatment of nearly seven years' duration. It will be noted that aside from the downward and backward rotation of the mandible and a slight further opening of the bite there has been no change. On the other hand, there has been growth of this mandible, as indicated by the superposed drawings of this part.

Another case of a similar nature (Fig. 14) shows a very nice growth over a period of five years, during which time the case was treated. It will again be noted that there has been no change in the general form of the bone, and I can assure you that there has been no improvement in the patient's appearance.

Here again we are dealing with a congenital defect which has caused a distortion at a time before all growth centers were operating. Upon this distorted pattern the regular rates of bone growth have occurred and there has been no change in the condition, for better or for worse, throughout all this time. Our assumption is that the growth center at the head of the condyle has been prevented from expressing its full potential through some adverse factor operating at a very early stage of its development. These precious days, subtracted as they were at the time when this part should have been expressing its highest rate of growth, will never be made up. It is interesting, however, that once recovery has occurred everything has gone along in the usual manner.

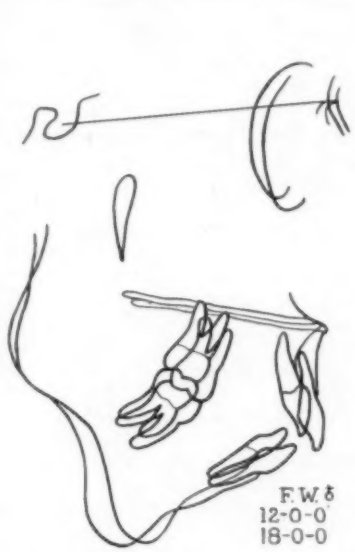

Fig. 13.

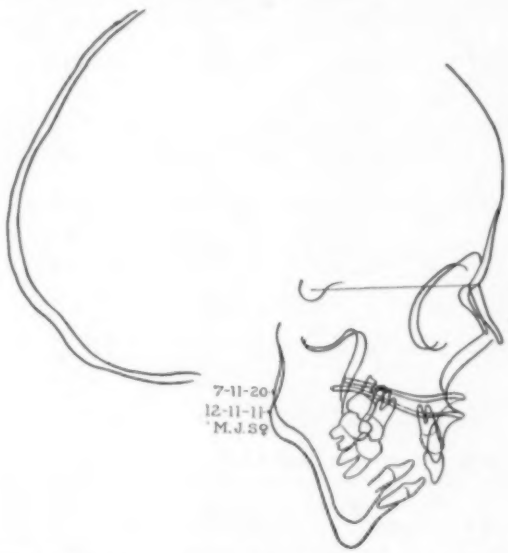

Fig. 14.

Fig. 13.—Tracings of a patient exhibiting mircomandibular development. Note short ramus, abnormal symphysis height and warpage of lower mandibular border. Differences in mandibular position are due to treatment.

Fig. 14.—Micromandibular development. Note that there has been no change in pattern with growth.

Ankylosis.—The last case which I shall show you (Fig. 15) is in the nature of experimental evidence. The patient, a girl, was afflicted with an ankylosis of both temporomandibular joints following Pott's disease. It was decided that a resection of both condyle heads would have to be performed in order to give her jaw movement. Since she was also a Class II malocclusion it was thought that both conditions might be corrected simultaneously. With this end in view an appliance was placed immediately following the resection of the mandible and the bite was jumped from a Class II to a Class I relation. Fortunately, x-ray pictures were taken before treatment was started and these were repeated at intervals throughout the course of treatment. The mandible at this time was normal in form and in size.

Five years later the patient was examined again and, much to our surprise, we found that although growth in every other part of the face had progressed in a normal manner, her mandible showed a complete arrest, and had become distorted in a manner similar to that exhibited by the Vogelgesicht. (Fig. 16) This seems to us good evidence that the primary etiology of the microman-

dibular deformity is an early arrest of condylar growth, followed by recovery. In the case of this patient the deformity had its inception when this growth center was surgically removed and thus lost its role as an adjustor. Here we have an example of the effect of accident on a particular growth site. This is the only case in which we have been able to demonstrate any postnatal change in pattern.

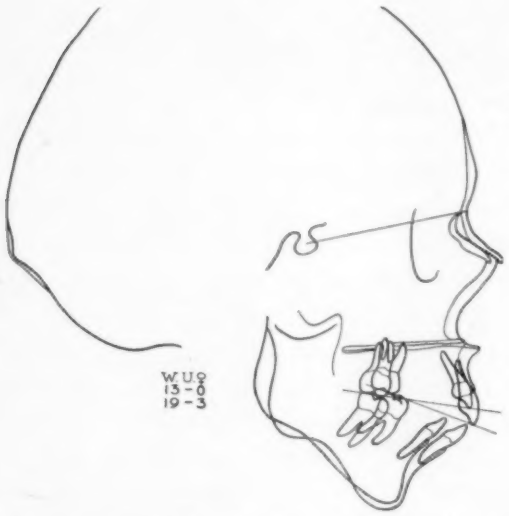

Fig. 15.

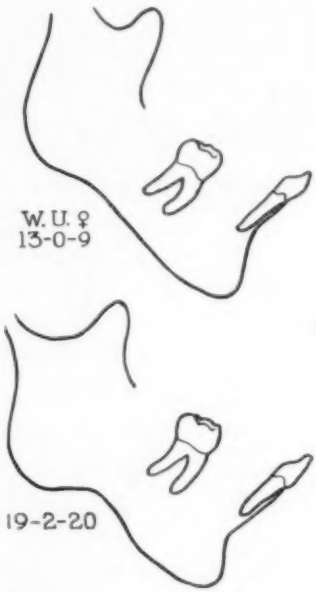

Fig. 16.

Fig. 15.—Tracings of a patient before and five years after condyle resection for treatment of ankylosis. Note normal growth of all parts except mandible.

Fig. 16.—Tracings of mandible of patient shown in Fig. 15. Note warpage of mandible following loss of growth center in condyle.

SUMMARY AND CONCLUSIONS

1. Investigations on the teeth have indicated that the growth process may be divided into certain definite phases. These are: (1) initiation, (2) proliferation, (3) histodifferentiation, (4) morphogenesis, (5) apposition. This presentation deals principally with the last two, viz., morphogenesis and apposition.

2. Morphogenesis is that stage wherein the basic pattern or "blueprint" of the part is laid down. Upon this pattern appositional growth will take place.

3. Appositional growth follows definite patterns that may be expressed as gradients: (a) growth begins at a "center" and spreads toward the periphery (locus gradient); (b) growth is most intense at this center and diminishes peripherally (rate gradient); (c) the growth rate is highest when the cells begin their activity and slowly diminishes (age gradient); (d) growth centers do not appear simultaneously but in a definite and orderly sequence (time gradient).

4. The same general principles and gradients as those governing the teeth may be shown to operate in skeletal growth.

5. Adverse constitutional factors operating during the various stages of development can affect only the sites or processes active at that time. Such disturbances are therefore seen to be on a time basis rather than on a basis of specificity of the operating agent.

6. The effects of an arrest do not seem to be compensated for by a subsequent acceleration of growth of the affected part. This results in a disproportion of attained size between parts, or distortion.

7. Adverse factors operating while all growth centers are active can cause generalized arrests which will result only in a failure to attain optimal size.

8. Accidents to, or surgical interference with, isolated growth centers can lead to distortion of form at any time during the growth period.

9. Deformities, except for the last named variety, show neither improvement nor regression with growth. They merely become more readily discernible. Their growth pattern is the usual or normal one, but it is superposed upon a distorted blueprint or form of the part.

REFERENCES

1. Baldridge, J. P.: A Study of the Relation of the Maxillary First Permanent Molars to the Face in Class I and Class II Malocclusions (Angle). Master's Thesis, Angle Orthodontist **11**: 100, 1941.
2. Brodie, A. G.: Some Recent Observations on the Growth of the Face and Their Implications to the Orthodontist, Am. J. Orthodontics and Oral Surg. **26**: 741, 1940; and On the Growth Pattern of the Human Head From the Third Month to the Eighth Year of Life, Am. J. Anat. No. 2, March 15, 209-262, 1941.
3. Crouzon, O.: Dysostose Cranio-Faciale Hereditaire, Bull. et mem. Soc. med. de hôp. de Paris **33**: 545, 1912.
4. Elman, E.: Studies on the Relationship of the Lower Six-Year Molar to the Mandible, Angle Orthodontist **10**: 24, 1940.
5. Engel, M., Bronstein, I. P., Brodie, A., and Wesoke, P.: A Cephalometric Roentgenographic Appraisal of Treated and Untreated Hypothyroidism, Am. J. Dis. Child. **61**: 1193, 1941.
6. Pesme, P.: Étude radialogique d'un cas da maladie de Crouzon, Bull. et mem. Soc. de radiol. med. de France **18**: 149, 1930.
7. Sarnat, B. G., Schour, I., and Heupel, R.: Roentgenographic Diagnosis of Congenital Syphilis in Unerupted Permanent Teeth, J. A. M. A. **106**: 2745, 1941.
8. Schour, I., and Massler, M.: Studies in Tooth Development: The Growth Pattern of Human Teeth, J. A. D. A. **27**: 1778, and 1918, 1940.
9. Thompson, J. R.: A Cephalometric Study of the Movements of the Mandible, J. A. D. A. **28**: 750, 1941.
10. Weiss, Paul: Principles of Development, New York, 1939. Henry Holt and Company.

RATIONALE OF TREATMENT WITH THE MODIFIED EDGEWISE ARCH MECHANISM

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LOOKING back over fifty years of hectic orthodontic progress, with the spotlight constantly shifting from one type of appliance to another, Dr. H. C. Pollock in a highly illuminating editorial[1] observes: "All the way from the base metal, grass line, and wire-ligature epoch up to the present it has been equally important and interesting to observe gross failures as well as successes by the use of all techniques. . . ; so successful practice, it would seem, requires skill, experience, precision, patience, and an orthodontic sixth sense, the kind of appliance notwithstanding in the end result."

The wisdom of the above observation is keenly brought home as we watch the parade of appliances. Those of us who have embraced one of the many "new techniques" in the hope that it would end our orthodontic ills have found that it still requires "an orthodontic sixth sense" to accomplish results. Nevertheless, when the late Dr. Angle gave the "edgewise technique"[2] to the profession in 1925, it marked a milestone in appliance design. He foresaw that an effective appliance must provide for all the necessary tooth-movements, each tooth in the arch moving simultaneously in the direction of the ideal arch form. By banding each tooth and soldering brackets and staples in strategic places and then inserting a rectangular arch wire (applied edgewise) of predetermined form, Angle found that the time of treatment could be effectively shortened. All the ligated teeth were thus moving in the direction of the final arch form rotations as well as bodily movements being accomplished at the same time.

However, there were many orthodontists who were reluctant to adopt the new technique because of certain deficiencies: the rigidity of the arch wire as it was locked into the horizontal bracket, the excessive strain on the teeth caused by the use of a heavy edgewise arch, and the skill necessary to accomplish the careful bending of the arch wire in order to obtain the torqueing action on teeth requiring root movement.

It was to overcome these "deficiencies" that the modified technique was introduced in 1937 by Sved.[3] The chief feature of this procedure is the modified bracket design, Fig. 1*A*. Instead of the horizontal slot the channel in this improved bracket is formed by two opposing wedges. This permits "the turning of the arch wire in the slot, so that the relationship between the axis of the tooth and the arch wire can be changed". . . . a fact which is not possible with the original Angle bracket.

It will be noticed that the grooves behind the upper and lower arms of the bracket provide for firm attachment of ligatures, which are applied very easily

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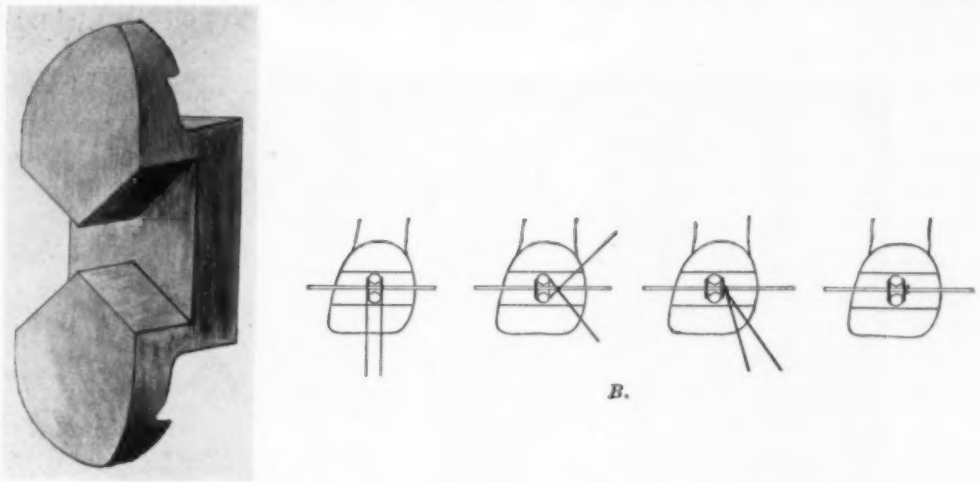
as illustrated, Fig. 1*B*. This modified bracket, moreover, permits every one of the following tooth movements without pliering the arch wire, Fig. 2:

1. Labial; 2. lingual; 3. occlusal; 4. gingival; 5. mesial; 6. distal; 7. rotation; 8. labial root movement; 9. mesial root movement; 10. distal root movement.



A. *B.*

Fig. 1.—*A*, The modified bracket. *B*, Method of ligating arch wire into bracket.

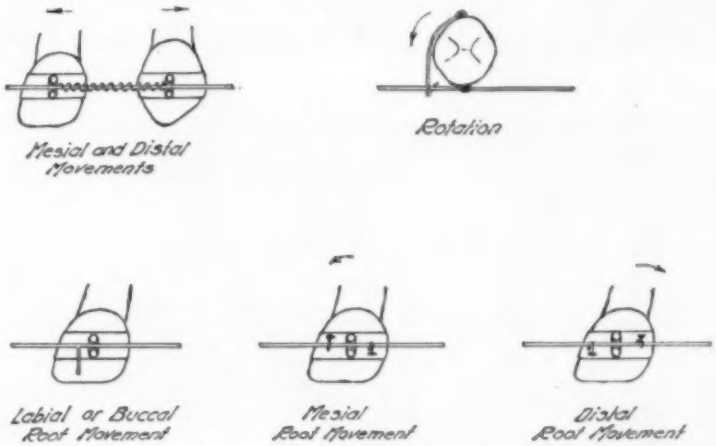


Fig. 2.—The various tooth movements obtained without pliering the arch wire. The mesial, distal, and rotating movements are obtained with the aid of staples soldered as illustrated.

TREATMENT

Before the teeth are banded for the insertion of the light stainless steel arch wire (.014 to begin with) a careful study should be made of the casts. If the case presents a unilateral or bilateral asymmetry, this should be corrected first. An effective technique for correcting such asymmetries was developed by Sved.[4] Fig. 3 shows a case of malocclusion with a unilateral asymmetry. Note how the posterior teeth on the right side have drifted forward as a result of the delayed eruption of the cuspid. It will be noted that the molar and premolar relationships on that side appear to be normal, which is due to the mandible having shifted over to the left in an attempt to maintain occlusion with the maxillary posterior teeth. The shifting of the mandible is indicated by the

position of the center line in the mandible, Fig. 3*B*. Fig. 4 shows a similar condition, but the asymmetry is bilateral. The upper posterior segments on both sides have drifted forward one-half the molar width. The distal movement of the maxillary posterior teeth must be accomplished before the edgewise appliance is inserted. The appliance for accomplishing this is illustrated in Fig. 5.

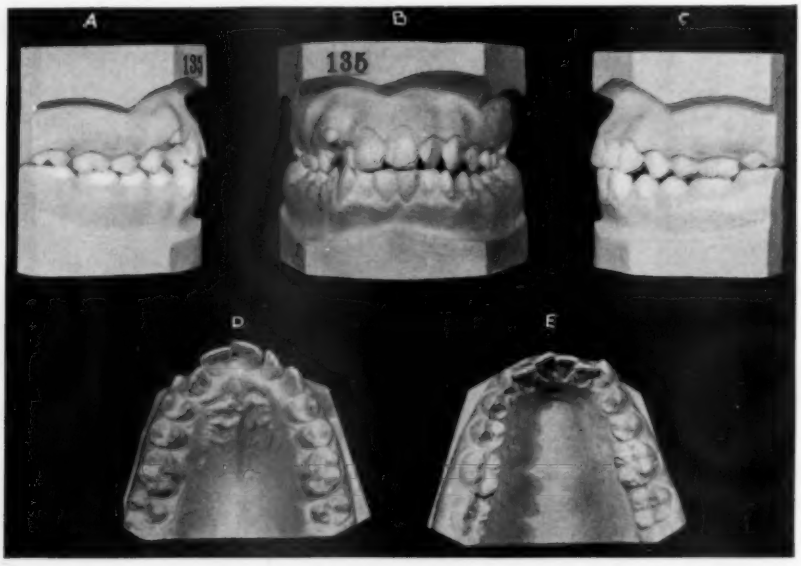


Fig. 3.—A case of unilateral asymmetry.

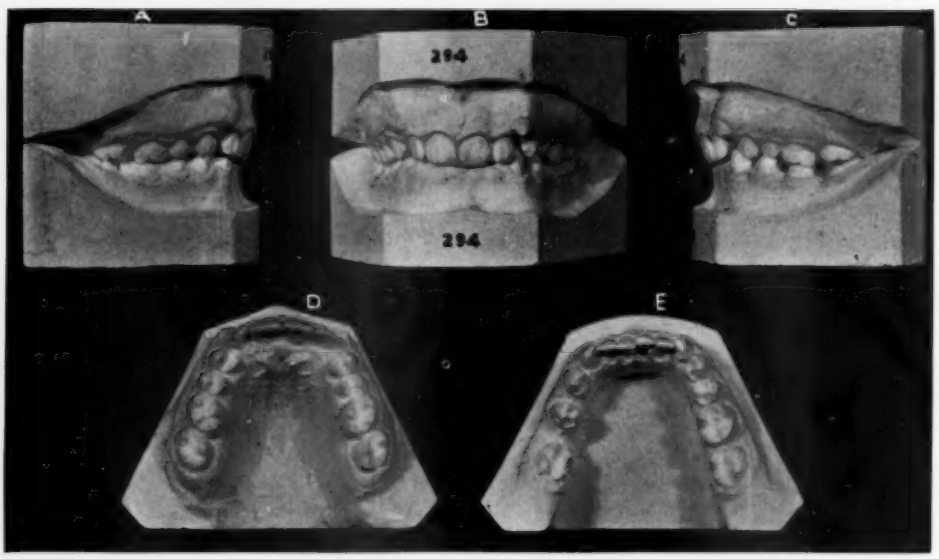


Fig. 4.—A case of bilateral asymmetry; patient, aged 13 years.

It will be observed that the central and lateral incisor teeth are banded. Usually, it is sufficient to band the cuspid (if erupted) on the side which is to have the distal movement. The first premolars and first molars on both sides are banded. After the six bands (five, if the cuspid is used) have been constructed directly in the mouth, a plaster impression (if colloid material is used,

leave substantial seams on the lingual surfaces of the bands for seating) is taken; the bands are seated carefully in the plaster, and a stone model is poured up. It is advisable to place burrs in the bands while packing the stone as an aid in preventing the teeth from breaking off during the soldering.

CONSTRUCTION OF THE APPLIANCE

The first step in the construction of the appliance is to solder two .028 wire stabilizers joining the premolars and molars on both sides, Fig. 5*D*-1. The remainder of the appliance is made with .040 wire. The next step is to join the lateral and central bands by means of a heavy wire to the first premolar band, Fig. 5*D*-2. After that has been accomplished, join the first premolar and the first molar on the right side with a heavy curved wire, Fig. 5*D*-3, which fixes the posterior teeth on that side for the part they are to play as a resistance unit. Similarly, on the left side first to be moved distally, solder a curved wire joining the first premolar and first molar, Fig. 5*D*-4. Before the curving of this wire is accomplished, slip on a buccal tube (¼″ long) of the same gauge as the wire, Fig. 5*D*-5. With the free-sliding tube as far back as possible on

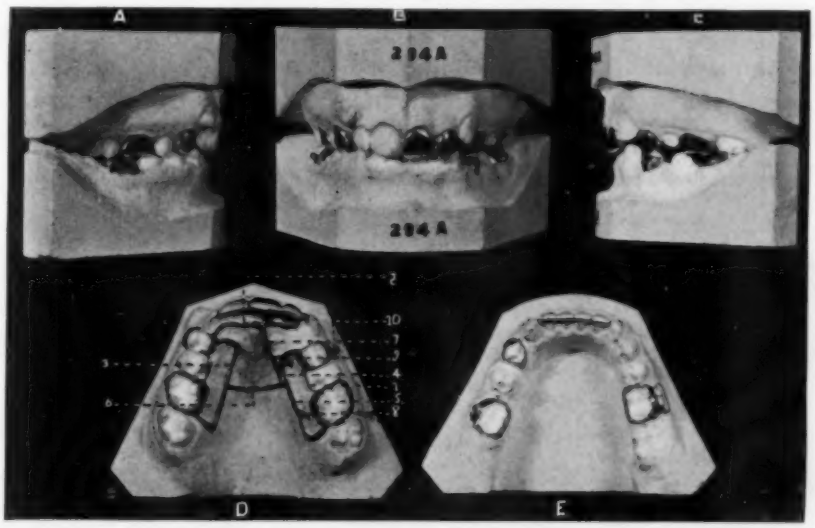


Fig. 5.—*A*, The correction of the asymmetry on this side was accomplished after the correction on the left side illustrated in *C* and *D*. *B*, Front view of appliance showing the six banded teeth in the maxilla. *C*, Note the extensive distal movement that was accomplished on this side to make room for the cuspid; compare with Fig. 4*C*; note hook for intermaxillary elastics on first premolar; note also how the first mandibular premolar had to be depressed to get it out of the way of the maxillary first premolar which was moving distally. *D*, Occlusal view of appliance used for correcting asymmetry on left side. The position of the appliance indicates the end result of the distal movement. The appliance is ready to be transferred to the other side. *E*, Occlusal view of mandibular arch showing assemblage for plain labial wire; a vertical tube was used on the left second molar to permit use of finger springs for moving premolars mesially.

the wire, solder it on its mesial end to a palatal wire (Fig. 5*D*-6) joined on the other end to the curved bar on the right side. As a further aid in fixation, solder a crosspiece (Fig. 5*D*-7) from the anterior wire to the palatal wire. The soldering of intramaxillary hooks completes the appliance: one goes on the distal end of the tube (Fig. 5*D*-8) another goes on the anterior part of the curved wire (Fig. 5*D*-9) and the third is soldered on the buccal surface of the left first premolar band (Fig. 5*D*-10). This hook is to provide additional intermaxillary pull from the mandible . . . a plain labial wire being sufficient for this purpose

(Fig. 5*E*). The insertion by the patient of No. 0 elastics on the two palatal hooks is all that is necessary to operate this appliance. Of course, all the bands in this appliance are cemented on the teeth at one time.

It will be noted from an examination of the appliance that the only movable segment is that included between the first premolar and the first molar on the left side . . . the rest of the appliance from the left lateral incisor to the left first molar is fixed and acts as a resistance unit. The application of elastic force, palatally and labially must result in the distal movement (bodily) of all the posterior teeth on the left side. The cast in Fig. 5*D* shows the end result of such movement in a period of five months. (Compare with Fig. 4*D* at beginning of treatment.) The appliance is now ready to be removed and reassembled so as to accomplish distal movement on the right side.

At this point it is wise to introduce a word of caution, and this has to do with a fundamental problem in diagnosis. Not all malocclusions where the cuspids are locked out are cases for the distal movement appliance. In Fig. 6 we see a malocclusion which simulates the asymmetries noted in Figs. 3 and 4. Upon closer scrutiny it will be seen that the mesiodistal relationship is fairly good on both sides; also the line of symmetry in the anterior region of the mandible corresponds with the center line in the maxilla. This can only mean one thing: the lack of room for the maxillary cuspids is due to insufficient width and underdevelopment of the bone in the incisor region. Simple expansion and bodily movement of the anterior teeth are therefore indicated and not distal movement of the posterior segments.

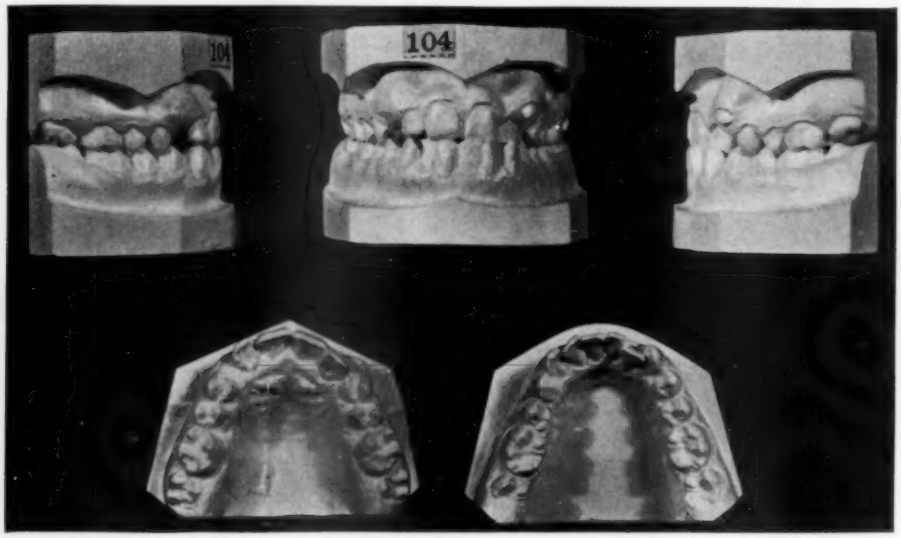


Fig. 6.—A case which simulates a bilateral asymmetry. The cuspids are locked out because of a lack of development in the premaxilla.

To get back to Fig. 5, when the asymmetry has been corrected, the case is ready for the modified edgewise assemblage. Every tooth is banded, using ⅛ inch material with the modified alignment bracket soldered in the center of the band. It is advisable to solder a staple on the lingual surface of each band, should rotation be necessary; also solder additional staples for tipping or bodily movements, Fig. 2.

When all bands have been cemented, the ideal arch wire (.014 round stainless steel) is tied into the brackets. The method for predetermining the arch form for each individual case is clearly explained in Sved's original article[5] on modified edgewise technique. All the necessary rotation and vertical alignment of the teeth are accomplished at one time because the teeth are automatically being moved in the direction of the ideal arch. The arch wire is gradually increased in thickness to .018, after which the edgewise arch (.022 by .028) is inserted. The heavier wire permits the necessary premolar and molar expansion and provides a basis for intermaxillary anchorage. The addition of intermaxillary hooks to the stainless steel rectangular wire can be accomplished without direct soldering by attaching two hooks to the ends of a square tube, Fig. 7, then cutting the tube in half. Each portion of the tube, with hook, is slipped on the .022 by .028 wire and "crimped" into the correct place on the arch. This provides effective intermaxillary anchorage in conjunction with the heavy steel wire.

Fig. 7.—Rectangular steel edgewise arch wire with intermaxillary hooks on tubes.

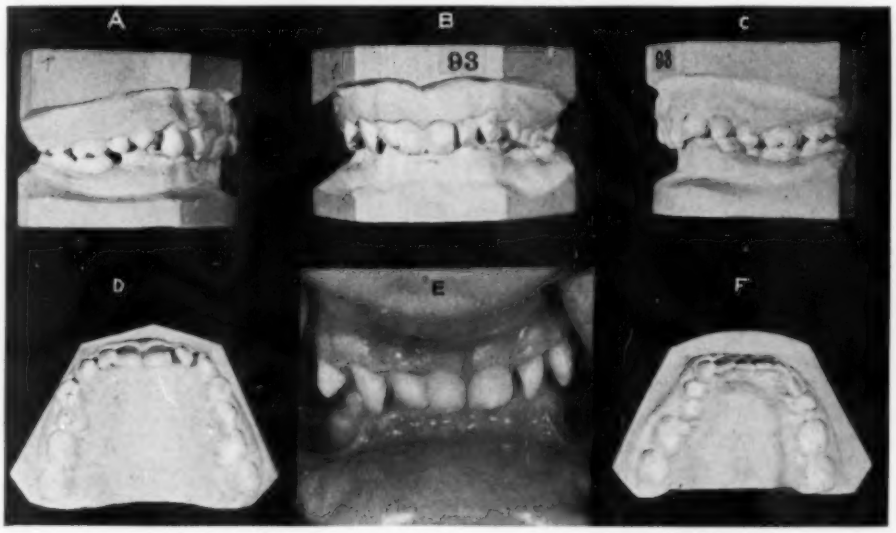


Fig. 8.—Case before treatment with modified edgewise technique; patient, aged 15 years. This case was treated at the Hospital for Joint Diseases.

TREATMENT OF A CASE WITH THE MODIFIED EDGEWISE MECHANISM

The case shown in Fig. 8 was treated with the modified edgewise mechanism at the Hospital for Joint Diseases (Orthodontia Department) by the author. The total length of time required for treatment of this case (Class II, Division 2, Angle), was approximately eighteen months. Due to the extreme overbite, it was not possible to place any bands with attachments on the mandibular teeth until the maxillary anterior teeth had been moved labially. Hence bands were

first placed on all the maxillary teeth. After about five insertions of (.014 to .016 ideally shaped arch wires) and upper bite plate was constructed. This was used to permit the mandibular premolars, which were completely lingual to the maxillary teeth, to be moved into the proper buccolingual relationship. Bands were then constructed and cemented on all the mandibular teeth. Coil springs were inserted between the first premolars and first molars in order to make room for the locked-out second premolar on the left side and the impacted second premolar on the right side. The deep overbite was automatically corrected because the arch wire, being in a flat plane, elevated the posterior teeth and depressed the anterior teeth. Rectangular wires (.022 by .028) were then inserted and intermaxillary anchorage applied in order to bring the mandible forward. Fig. 9 shows the finished result. It will be noted that an ideal occlusion has not been obtained due to the extreme underdevelopment of the mandible and its small apical base. This is borne out by an examination of the photographs before and after treatment, Fig. 10. Note the improvement in the appearance shown in the front view. This, of course, was the result of the reduction of the overbite. A study of the occlusal views of the mandible before and after treatment (Fig. 8*F* and 9*F*) will show how much larger the arch was after treatment. However, even the flaring out of the anterior teeth was not sufficient to make up for the disharmony in apical base between the maxilla and mandible.

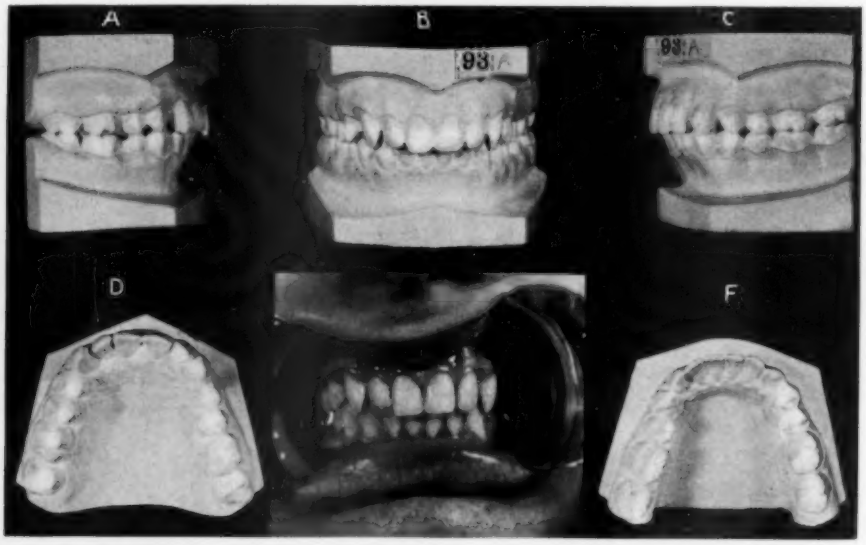


Fig. 9.—Same case as Fig. 8 after 18 months of treatment; note that the impacted mandibular right second premolar is in normal position (see *F*).

CONCLUSION

The author does not profess to make any exaggerated claims for the modified edgewise technique other than it has been found effective and a great time-saver. Cases that formerly required three years of treatment now require half that time, with less frequent visits by the patient. Each insertion of the predetermined arch makes for definite action on each tooth . . . rotation and bodily movement taking place according to a timetable. It has been found most effective in deep overbite cases, practically eliminating the necessity of the

patient wearing a bite plate. The appliance seems to combine the gentle action of the plain labial arch with the advantages of the Angle edgewise arch, without any of their disadvantages. It also provides a simple way of opening and closing spaces between teeth by the use of the coil springs inserted on the arch wire. In addition, by using the distal movement appliance to correct asymmetries before the modified edgewise mechanism, an effective way is provided for quickly moving a whole segment distally without tipping or straining of the teeth. This latter appliance eliminates the frequently observed "toothy" appearance of corrected cases where the anterior teeth were moved labially to make room for locked-out cuspids instead of moving the posterior teeth distally.

Fig. 10.—*A*, Front view of patient before treatment. *B*, Lateral view of patient before treatment. *C*, Front view of patient after treatment; note how the increase in vertical height in the posterior part of the jaws has changed the compression of the lips observed before treatment. *D*, Lateral view after treatment.

REFERENCES

1. Pollock, H. C.: Editorial, Am. J. Orthodontics and Oral Surg. **27**: 226, 1941.
2. Angle, Edward H.: The Latest and Best in Orthodontic Mechanism, Dental Cosmos **70**: 1143, 1928.
3. Sved, Alexander: Principles and Technique of Modified Edgewise Arch Mechanism, Am. J. Orthodontics and Oral Surg. **24**: 635, 1938.
4. Idem: Ibid.
5. Idem: Ibid.

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All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. J. A. Salzmann, 654 Madison Avenue, New York City.

Inheritance of Human Facial Features: By M. R. Lebow and P. B. Sawin, *J. Heredity* **32**: 127-132, 1941.

The fact that certain characteristics of teeth and gums are inherited in a simple Mendelian manner, with a regularity which would make possible the prediction of the recurrence of the character in subsequent generations is of importance to dentists. If the disharmonies of the underlying osseous tissue of the jaws, and the conformation of the overlying skull, which long have been puzzling, should likewise prove to have an hereditary as well as an environmental background, an entirely new approach to the correction of such defects would be necessary. Since rational treatment of any abnormality necessitates a correct diagnosis and the determination and removal of underlying causes, the ability to distinguish developmental influences of an inherent nature, if they do actually exist, is imperative and such knowledge should be applied in diagnosis and treatment.

The attention of one of the authors (M. R. L.) was attracted to the striking contrast in facial conformation manifest in a brother and sister then under treatment. Through the interest and cooperation of their living relatives, it has been possible to assemble a pictorial pedigree which enables them to trace several not uncommon facial features for seven generations to ancestors settling in Rhode Island at about the time of Roger Williams. These were, prominent ears, a prominent nose, a cleft chin and an unusually long face. The manner in which the long face character not only appears to run in the family but the way in which it segregates in a more or less regular fashion is worthy of more than passing notice.

Contrasting types in facial shape were first observed in the two children, sister and brother, the former possessing a broad or round face whereas the latter has a long face. The origin of the long face character can be traced back seven generations through the great-great-grandmother to the original maternal ancestor from whom are descended thirteen long-faced individuals.

Several interesting facts of genetic significance are evident:

1. Long face occurs rather *infrequently* and *from round-faced parents.*
2. It *skips generations* as in the case of one individual who could have obtained the trait from either his great-grandmother or his grandfather by way of his parents who were first cousins. One individual likewise obtained it from his great-grandmother.

3. *Mating of round-faced hybrid carriers of long face* to long-faced individuals *produces* both *long- and round-faced progeny.* They are not in equal numbers as might be expected if the trait were transmitted in a simple Mendelian manner, but the number of progeny is small.
4. *Mating of known heterozygotes produces both kinds of progeny* although the numbers are too small to form a significant ratio.
5. Only one mating of *long face by long face* is at hand. These individuals have one daughter who is long faced. Additional matings of this type are of special interest in order to determine whether or not they breed true, as they should if long face is a simple recessive.

Each of these listed observations is a characteristic frequently found in a pedigree of a trait which segregates in a typical and simple Mendelian manner. It would be folly, however, to draw the definite conclusion from this meager data that the manner of inheritance of this trait is of this simple nature. Both measurements display wide ranges of variation within races which in some cases are overlapping. It is quite probable that if all of the individuals in the above pedigree could have been subjected to quantitative measurement there would be a similar overlapping of types.

Nevertheless, the repeated appearance of the long face in successive generations regardless of the phenotypes of the marriage partners concerned is difficult to conceive of as resulting either from environmental forces alone or as being due to the fortuitous recombination of any great number of hereditary influences. Since no two individuals develop in absolutely the same environment, phenotypic variation is always present and this may account for the observed small departures from the strict long- or round-faced types. It is also quite possible that certain families, even certain racial groups are homozygous for face shape. Thus we may get a more simple pattern of inheritance in some families than in others.

A second character, the presence of a striking dimple or cleft in the chin, had its beginning in this family where it was so well developed as to be a nuisance in shaving. The fact that the character was directly transmitted suggests dominance of the character. However, the cleft is also transmitted indirectly. Thus, the trait has skipped a generation making its inheritance as a recessive the more probable, although neither interpretation here has adequate proof. Similarly, a prominence of nose has been recognized as a family trait.

A pictorial pedigree of seven generations and forty-two individuals manifests a segregation of the characters, long versus round face, prominent nose and ears and cleft in the chin in a manner which is in harmony with simple Mendelian interpretations, if it is assumed that minor variations are phenotypic in their origin. Attention is called to the significance of such variation in the practical treatment of facial conformation by the orthodontist.

Editorial

Youth Physically Under Par

Since Selective Service statistics have released the shocking information that one-half of the country's young men are unfit for military service, the urgency of a nationwide move for the improvement of the general health of the American people becomes obvious.

Eyes, ears, teeth, feet, hearts, legs, and bodies were all included in the physical limitations, revealed as so prevalent in modern youth. Such figures are astonishing even to those whose lives are spent in health service pertaining to the physical improvement of modern youth; notwithstanding many clinical workers have surmised that all was not as well as it seemed.

Dental defects lead the list of disqualifications with 20.9 per cent, eyes 13.7 per cent, cardiovascular 10.6 per cent, and so on down the line, in the regular order of incidence.

With such facts now revealed the query quickly arises: Why is it that so many young fellows are in such poor physical shape, in a country in which all the health sciences have made such rapid advance in the last quarter of a century?

Obviously, even physicians do not know all of the answers to these questions, and it is possible that persons in other walks of life may know something about it. Athletic directors and college coaches, for instance, may know something about the source from which some of the defects in modern youth arise, because they get a "close up" of the mass action of modern youth as it is lived today. To peruse some of the coaches' recent observations one quickly gets the impression that they believe that youth, in many instances at least, is unwittingly suffering from malnutrition as a result of poor and unnatural habits of life.

Here is what one of the coaches says about it: "The ordinary student at college practically chooses his own mode of living. It is rarely regular. Where a boy has meager financial resources, a couple of 'hot dogs' may constitute his daily rations. He may sleep in a poorly ventilated room or in one poorly heated. Some are underfed; others overfeed themselves. Both can lead to sickness and sluggishness." So forth and so on the coaches at great length describe the abnormal life of many college students, but it all sums up to the one big point in the end that the coach believes college life is entirely too much high pressure, poor diet, last minute worry over passing examinations, stress after stress, with athletics only for the few in so far as actual physical benefit is concerned. They go on to say that too many pay no attention to proper diet and leave themselves in no shape to benefit from their recreation athletics even when they have the opportunity.

The college student of America, of course, is only one small segment of society. However, shift the scenery just a trifle to the left or right of the above picture, and it can be applied to the tempo of most any division of American life. The story is not unlike the classical retort that the average physician gives to the question as to why heart disease is so much on the increase during the present generation: he says people are not living according to the laws of nature and that the pace is too fast.

Whether it be teeth, bone, heart, eyes, or "what have you," all can be indirectly affected, apart from their normal function, by the chronic disturbance of nutrition and metabolism. Poor diet and bad habits of living, physicians tell us, take their toll in malnutrition much more quickly than the average layman realizes.

The coach perspective is interesting to all men working with youth because they can understand the viewpoints. Anyone who spends his life in administering any kind of health service to the generation growing up in America cannot avoid being impressed with the physical softening and lack of toughening-up process that is taking place, probably as a result of air-conditioned effortless living that does not fit in with good vital metabolism and rugged health.

Schools keep children indoors all day long week after week, month after month, and year after year. It is true the most of them have an athletic program; however the nutrition-minded individual knows it is rather a gesture and its benefit for real physical toughness of all the people only scratches the surface of the problem.

The automobile, no doubt, has robbed youth of much of its exertion of natural physical effort in growing up. The automobile in the aggregate has eliminated billions of hours of physical exercise and efforts for thousands of youths in the process of growing up. The tremendous physical benefit of plenty of outdoors, sunshine, and exercise along with a wholesome, well-balanced diet has been amply proved by the compiled reports of the CCC experience. It is too bad so few realize the physical benefit to be derived by youth from such a simple formula—perhaps it is too simple to be taken seriously.

When the physicians are interviewed about the Selective Service revelations, they say that whether the national health has improved or deteriorated since the First World War, the fact remains that draft records reveal a condition that cries for correction, as rapidly as the ways and means can be found to accomplish it. So, the question arises as to ways and means.

Not discounting the merits of all the various health improvement plans that are being proposed, many nutrition- and child-minded people believe that no more effective start can be made to improve this astonishing situation than to institute a general program for growing youth of all ages, of bigger and better outdoors and less indoors; more and better nutritional foods of proved nutritional value and less synthetic phoney foods that cater to and attract the sweet-tooth appetite of children; less worship at the shrine of mental I.Q.'s and more attention to the physical development of prospective men and women. Give physical fitness of the growing child the close attention that is directed to pure-

bred livestock or hybrid grains and the benefit to the physical fitness of the people would soon be far-reaching in its ramifications.

To see a swing back to physical fitness, the important goal of a nation for its youth, to see such a movement started at its source in childhood would no doubt be welcomed by a vast hoard of professional men who know that habits of life and diet have more to do with rugged health and a feeling of well-being than anything else, and that prevention is the place to attack most physical problems.

H. C. P.

Correspondence

President's Page

MEMBERS OF THE AMERICAN ASSOCIATION OF ORTHODONTISTS:

You have no doubt noticed the date *March 15* published in large type frequently of late. By chance I saw an advertisement yesterday, "*Start saving now for March 15th, due date for your New Federal Income Tax.*"

To the members of the A. A. O. I wish to say, "Start saving time now for *March 15*, as that will be the day you should be leaving for New Orleans, the place of the next annual meeting." It will be held on March 16, 17, 18, and 19, an ideal time for that winter vacation. And, no doubt, most of you will need it after filing your new tax. But, while saving for the tax, save a little on the side for this combination scientific and winter vacation trip.

The Program Committee, under the able direction of Chairman Dr. Earl Jones, Dr. George Anderson, and Dr. Brooks Bell, has just about completed the Scientific Program. While it is too early to give out all the information, there is a new innovation to be presented this year that will be of great interest. Much has been said on new and distinct therapies of orthodontic treatment; so this year it is planned to present as many different types of orthodontic therapy as is practical. This will be in the form of treatments and clinics. For instance, Wednesday morning of the meeting will be devoted to the treatment of a given case. The history and diagnosis of this case will be presented by Dr. Milo Hellman of New York City. The treatment of this case by the open-tube mechanism will be presented by Dr. James D. McCoy of Los Angeles, Calif., the labio-lingual mechanism by Dr. Oren A. Oliver of Nashville, Tenn., the edgewise mechanism by Dr. Samuel Lewis of Detroit, Mich., the universal mechanism by Dr. Spencer Atkinson of Pasadena, Calif., and the twin-arch mechanism by Dr. Joe Johnson of Louisville, Ky. On Thursday afternoon five major clinics of two and one-half hours' duration, showing the complete fabrication of these techniques, will be presented. The groups presenting these are being formed. We will give you complete details concerning these interesting clinics at a later date.

One of the most interesting phases of the meeting that is being developed is that of the Pan-American aspect. Under the guidance of the chairman of the Inter-Relations Committee, Dr. John W. Ross of Philadelphia, the work is progressing nicely, and we hope to announce the complete formation of this most important part of the meeting in the near future.

The beautiful Roosevelt Hotel of New Orleans has been selected as the headquarters for the meeting. It is none too early to start making your reservations. From time to time we will give you more detailed information concerning the Scientific Program.

Yours sincerely,

CLAUDE R. WOOD, President.

In Memoriam

Jesse D. White

Not only the City of St. Louis but the State of Missouri and the Nation have lost one of the much beloved and outstanding dentists. His was a professional career that many would emulate and one that was definitely constructive for his profession to the end.

Jesse White, as he was known to thousands, reflected in his character that intangible something, hard to define, that attracts and cements the confidence and respect of people. His modesty, disposition, and wholesome cheerfulness reflected a sincerity of purpose that gained for him the respect of all who knew him. He enjoyed a wide acquaintance and friendships as well among orthodontists and oral surgeons in America, probably for the reason that he had watched with great interest the advance of both of these specialties from their infancy and could recite the most interesting history of the advent of both of these specialties of dentistry.

Dr. White was former dean of Washington University School of Dentistry, with which he was associated for more than 30 years, until his retirement in 1936. He was regarded as one of the outstanding teachers in dentistry, particularly in the field of crown and bridge work.

In 1937 a bronze plaque was placed in his honor in the foyer of the dental school where he had taught for so many years of his life. His membership and honors in dental organizations were far-reaching and to list them all would be an important undertaking in itself.

He entered the Indiana Dental College in 1892, and a year later came to the Missouri Dental College. After practicing six years at Illiopolis, Ill., he returned to St. Louis and took his degree in dentistry in 1901 at the newly organized Washington University School of Dentistry. For the next three years he practiced at Springfield, Ill. Washington University then offered him a position as instructor in prosthesis, or dental construction. He attained the rank of professor and from 1932 to 1936 served as dean of the school.

Surviving are Mrs. White, the former Miss Consuella M. Cowden of Illiopolis, Ill., a son, Dr. Donald C. White of St. Louis, and a daughter, Mrs. Dorothy White Thomas of Houston, Texas.

What finer memory can one leave to family and friends than that he enjoyed the confidence, love, and respect of all who knew him? Such will be the memory of Jesse White to his friends.

Special Report

A. A. O. Public Relations Bureau

EDITOR, AMERICAN JOURNAL OF ORTHODONTICS AND ORAL SURGERY
SIR:

The October issue of *Physical Culture Magazine* carried a popular article by Wainwright Evans entitled "Faces Made Over by Dental Magic." Considerable attention is paid by the writer to orthodontics. The Public Relations Bureau cooperated with Mr. Evans in the preparation of this manuscript which appeared in a journal with a circulation of 250,000.

"Crooked Teeth," an illustrated article by Benno E. Lischer, D.M.D., Dean of Washington University School of Dentistry, St. Louis, Mo., appeared in the November issue of *Life and Health*, published at Takoma Park, Washington, D. C.

The Committee decided to order 10,000 reprints of the article by Dr. James David McCoy, "The General Health Benefits of Orthodontic Treatment," which appeared in the July issue of the JOURNAL. These will be made available to members of the Association and others interested in the distribution of our educational material.

At the request of Dr. W. Ross Batson, Editor of the *West Virginia Dental Journal*, permission was given to reproduce the leaflet, "Getting Ready to Tackle Life."

The American Public Health Association has made it possible for us to distribute to their entire membership mailing list of 7,000 names, copies of "Getting Ready to Tackle Life." A large amount of correspondence resulted from this mailing showing a considerable interest in the subject of orthodontics among public health persons.

Total distribution of this document now aggregates 50,500 copies, leaving a supply on hand of 57,500.

A transcription of the radio talk made by Drs. Leuman H. and Donald B. Waugh at the annual meeting in New York City last May was supplied the Pacific Coast Society of Orthodontists and rebroadcast in connection with the Southern California State Dental Association in Los Angeles in September. Transcriptions of this talk, as well as of the one made by Dr. Henry U. Barber, Jr., at the annual meeting, are available for use by other societies at the cost of making copies, $5.00, plus cost of mailing.

DWIGHT ANDERSON, Director, Public Relations Bureau,

American Association of Orthodontists.

News and Notes

American Association of Orthodontists

The 1942 meeting of the American Association of Orthodontists will be held at the Roosevelt Hotel, New Orleans, La., March 16 to 19, 1942. This will be a Pan-American Congress. A very special invitation is extended to orthodontists in Central and South America.

Five-State Postgraduate Clinic

The annual Five-State Postgraduate Clinic of the District of Columbia Dental Society will convene at the Mayflower Hotel, Washington, D. C., March 8 to 12, 1942.

Dallas Midwinter Dental Clinic

The Dallas Midwinter Dental Clinic, sponsored by the Dallas County Dental Society, will hold its Fifteenth Annual Meeting in the Hotel Adolphus, Dallas, Texas, Jan. 26 to 28, 1942. The three-day study course will be conducted by the following clinicians: Dr. R. O. Schlosser, Chicago, Ill., who will conduct a course on "Denture Prosthesis"; Dr. Sanford M. Moose, San Francisco, Calif., who will present a course on "Oral Surgery and Diagnosis"; and Dr. Earnest R. Granger, Mt. Vernon, N. Y., who will conduct a course in "Operative Dentistry." Table clinics will be presented by members of the Dallas County Dental Society.

Chicago Association of Orthodontists

The Chicago Association of Orthodontists met at the Palmer House, Sept. 29, 1941. Dr. Byron O. Hughes of the University of Michigan read a paper entitled "Hereditary Growth of the Dental Facial Complex." The paper was discussed by Dr. Allan G. Brodie.

Southern Society of Orthodontists

The nineteenth Annual Meeting of the Southern Society of Orthodontists was held at the Hotel Sir Walter, Raleigh, N. C., Sept 29, and 30, 1941. A most enjoyable feature of the ladies' entertainment was a tour on Sunday afternoon of Duke University at Durham and of the University of North Carolina at Chapel Hill. On Monday afternoon the ladies were entertained at a tea at the Governor's Mansion.

At the scientific sessions the following papers were presented: "The Construction and Manipulation of the Twin-Wire Mechanism," Dr. Joseph E. Johnson, Louisville, Ky.; "A Consideration of Etiology," by Dr. Philip E. Adams, Associate Professor of Orthodontics at Tufts College, Boston; "Philosophy in Orthodontic Practice," by Dr. Clinton C. Howard of Atlanta, Ga., first president of the Southern Society; "Pioneers in Orthodontics," by Dr. Harry E. Kelsey, Baltimore, Md.; "Discussion of the Occlusal Guide Plane," by Dr. Russel E. Irish, Pittsburgh, Pa.; "A Report on the Experimental Treatment of a Certain Type of Malocclusion," by Dr. Bert G. Anderson, New Haven, Conn., and "Report of a Survey in the Use of the Guide Plane," by Dr. P. J. Thomas of Savannah, Ga. A number of clinics and case reports were presented.

At the business session Dr. W. P. Wood, Jr., of Tampa, Fla., was elected president for the coming year. Dr. M. Bagley Walker of Norfolk, Va., was elected president-elect, Dr. H. T. Gosney of Danville, Va., vice-president, and Dr. E. C. Lunsford of Miami, Fla., secretary-treasurer.

American Board of Orthodontics

The following men were certified by the American Board of Orthodontics in 1941:

Dr. F. Copeland Shelden
Plaza Medical Building
Kansas City, Mo.

Dr. E. Allen Bishop
Cobb Building
Seattle, Wash.

Dr. Louis Braun
David Whitney Building
Detroit, Mich.

Dr. James A. Burrill
25 East Washington Street
Chicago, Ill.

Dr. Burl Francis Dewel
708 Church Street
Evanston, Ill.

Dr. P. M. Dunn
Medical Arts Building
Minneapolis, Minn.

Dr. Meyer Eggnatz
Medical Arts Building
Baltimore, Md.

Dr. Bercu Fischer
2 East 54th Street
New York, N. Y.

Dr. James W. Ford
55 East Washington Street
Chicago, Ill.

Dr. Samuel Hemley
745 Fifth Avenue
New York, N. Y.

Dr. William C. Keller
40 East 49th Street
New York, N. Y.

Dr. Ruben E. Olson
Union National Bank Bldg.
Wichita, Kan.

Dr. William H. Pearson
Taylor Building
Norfolk, Va.

Dr. Franklin A. Squires
Medical Centre
White Plains, N. Y.

Dr. Alexander Sved
654 Madison Avenue
New York, N. Y.

Lieut.-Col. R. F. Thompson
Surgeon General's Office
Washington, D. C.

Dr. M. Bagley Walker
Medical Arts Building
Norfolk, Va.

Dr. Willis Hull Murphey
Medical Arts Bldg.
Fort Worth, Texas

Notes of Interest

Dr. John A. Rowe announces Dr. M. D. King, Jr., as his associate in the practice of orthodontics, Medical Arts Building, San Antonio, Texas.

Dr. J. Stier Cunningham announces the removal of his office to 2418 Travis Street, Houston, Texas. Practice limited to orthodontics.

Dr. George R. Moore announces that Dr. Chester D. Ward has become associated with him in the practice of orthodontics at 919 Oakland Avenue, Ann Arbor, Mich.

Dr. Ralph W. Short and Dr. Emory H. Farrington announce the removal of their office to Haddon Hall, 29 Commonwealth Avenue, Boston, Mass. Practice limited to orthodontics.

Dr. Ivan L. Staley announces the opening of his office Oct. 20, 1941, at 802 Metropolitan Building, St. Louis, Mo. Practice limited to orthodontics.

Dr. Leland R. Johnson, 180 N. Michigan Ave., Chicago, Ill., announces the opening of an office in association with Dr. Abram Hoffman at 2 North Sheridan Road, Highland Park, Ill. Practice limited to orthodontics.

OFFICERS OF ORTHODONTIC SOCIETIES*

American Association of Orthodontists

President, Claude R. Wood _ _ _ _ _ _ _ _ _ 608 Medical Arts Bldg., Knoxville, Tenn.
Secretary-Treasurer, Max E. Ernst _ _ _ 1250 Lowry Medical Arts Bldg., St. Paul, Minn.
Public Relations Bureau Director, Dwight Anderson
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 292 Madison Ave., New York, N. Y.

Central Association of Orthodontists

President, Harold J. Noyes _ _ _ _ _ _ _ _ _ 55 E. Washington St., Chicago, Ill.
Secretary-Treasurer, L. B. Higley _ _ _ _ _ _ _ 705 Summit Ave., Iowa City, Iowa

Great Lakes Society of Orthodontists

President, Frank S. Cartwright _ _ _ _ _ _ _ _ Henry Ford Hospital, Detroit, Mich.
Secretary-Treasurer, Richard E. Barnes _ _ _ _ _ _ _ 838 Keith Bldg., Cleveland, Ohio

New York Society of Orthodontists

President, Sidney E. Riesner _ _ _ _ _ _ _ _ _ _ 136 E. 36th St., New York, N. Y.
Secretary-Treasurer, William C. Keller _ _ _ _ 40 E. Forty-Ninth St., New York, N. Y.

Pacific Coast Society of Orthodontists

President, Ben L. Reese _ _ _ _ _ _ _ _ _ _ _ Roosevelt Bldg., Los Angeles, Calif.
Secretary-Treasurer, Earl F. Lussier _ _ _ _ _ 450 Sutter St., San Francisco, Calif.

Rocky Mountain Society of Orthodontists

President, George H. Siersma _ _ _ _ _ _ _ _ _ _1232 Republic Bldg., Denver, Colo.
Secretary-Treasurer, Curtis L. Benight _ _ _ _ _ _ 1001 Republic Bldg., Denver, Colo.

Southern Society of Orthodontists

President, W. P. Wood, Jr. _ _ _ _ _ _ _ _ _ _ 442 W. Lafayette St., Tampa, Fla.
Secretary-Treasurer, E. C. Lunsford _ _ _ _ _ _ 2742 Biscayne Blvd., Miami, Fla.

Southwestern Society of Orthodontists

President, E. Forris Woodring _ _ _ _ _ _ _ _ _ _ Medical Arts Bldg., Tulsa, Okla.
Secretary-Treasurer, R. E. Olson _ _ _ _ _ _ Union Nat'l Bank Bldg., Wichita, Kan.

American Board of Orthodontics

President, Charles R. Baker _ _ _ _ _ _ _ _ _ _ _ 636 Church St., Evanston, Ill.
Vice-President, Frederic T. Murlless, Jr. _ _ _ _ _ 43 Farmington Ave., Hartford, Conn.
Secretary, Bernard G. DeVries _ _ _ _ _ _ _ _ Medical Arts Bldg., Minneapolis, Minn.
Treasurer, Oliver W. White _ _ _ _ _ _ _ _ 213 David Whitney Bldg., Detroit, Mich.
William E. Flesher _ _ _ _ _ 806 Medical Arts Bldg., Oklahoma City, Okla.
James D. McCoy _ _ _ _ _ _ _ _ 3839 Wilshire Blvd., Los Angeles, Calif.
Joseph D. Eby _ _ _ _ _ _ _ _ _ _ _ 121 E. 60th St., New York, N. Y.

Harvard Society of Orthodontists

President, Harold J. Nice _ _ _ _ _ _ _ _ _ _ 475 Commonwealth Ave., Boston, Mass.
Secretary-Treasurer, Edward I. Silver _ _ _ _ _ _ _ _ 80 Boylston St., Boston, Mass.

Washington-Baltimore Society of Orthodontists

President, Paul W. Hoffman _ _ _ _ _ _ _ _ 1835 Eye St., N. W., Washington, D. C.
Secretary-Treasurer, Stephen C. Hopkins _ _ _ _ _ 1726 Eye St., Washington, D. C.

Foreign Societies†

British Society for the Study of Orthodontics

President, S. A. Riddett
Secretary, R. Cutler
Treasurer, Harold Chapman

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*The Journal will make changes or additions to the above list when notified by the secretary-treasurer of the various societies. In the event societies desire more complete publication of the names of officers, this will be done upon receipt of the names from the secretary-treasurer.

†The Journal will publish the names of the president and secretary-treasurer of foreign orthodontic societies if the information is sent direct to the editor, 8022 Forsythe, St. Louis, Mo., U. S. A.

1908 Class of the Angle School of Orthodontia, St. Louis, Mo. *1*, . *2*, Blaine Truesdell. *3*, Allan. *4*, R. C. Osburn. *5*, William Savanagh. *6*, . *7*, Cecil George Moxham. *8*, William D. Riggs. *9*, Harry E. Kelsey. *10*, George D. Goodenough. *11*, Frederick B. Noyes. *12*, Martin Dewey. *13*, John V. Mershon. *14*, Alfred M. Desnoes. *15*, Albert F. Wayne. *16*, Albert H. Ketcham. *17*, E. H. Wuerpel. *18*, E. H. Angle. *19*, Frederick L. Stanton. *20*, Milo Hellman. *21*, H. E. Loeffler. *22*, Mataich Kihita. (Courtesy of Dr. B. W. Weinberger, New York.)